

P E N N S Y L V A N I A

Occupational Outlook Handbook

**2006
Edition**

Education and Training

Science, Research, Engineering & Information Technology

Volume 5 of 6

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toll-free at 1-877-493-3282.

How to Use the Pennsylvania Occupational Outlook Handbook

The *Pennsylvania Occupational Outlook Handbook* is best used as a reference; it is not meant to be read in its entirety. Instead, look in the Table of Contents for specific occupations that interest you. For any occupation that sounds interesting, use the *Handbook* to learn about the type of work, education and training requirements, advancement possibilities, earnings, job outlook, and related occupations. Each occupational description follows a standard format, making it easy for you to compare occupations.

This document provides an overview of how the occupational articles are organized in the *Handbook*. It highlights information presented in each section and offers tips on how to interpret the information.

Unless otherwise noted, the source of employment and earnings data presented in the *Handbook* is the Pennsylvania Department of Labor & Industry, Center for Workforce Information & Analysis. Nearly all *Handbook* articles cite employment and earnings data from the Occupational Employment Statistics (OES) survey. Some articles include data from outside sources. OES data may be used to compare earnings among occupations; however, outside data may not be used in this manner because characteristics of these data vary widely.

The following are descriptions of the subheadings that appear under each of the occupations included in this handbook:

Significant Points

This section highlights key occupational characteristics.

Nature of the Work

This section describes what types of activities are involved in a particular occupation. Individual job duties may vary by industry or employer. For instance, workers in larger firms tend to be more specialized, whereas those in smaller firms often have a wider variety of duties. Most occupations have several levels of skills and responsibilities through which workers may progress. Beginners may start as trainees performing routine tasks under close supervision. Experienced workers usually undertake more difficult tasks and are expected to perform with less supervision.

Working Conditions

It is important to research the working conditions of an occupation. This section identifies the typical hours worked, the workplace environment, physical activities and susceptibility to injury, special equipment, and the extent of travel required. In many occupations, people work regular business hours - 40 hours a week, Monday through Friday - but in many others, they do not. For example, waiters and waitresses often work evenings and weekends.

Employment

This section reports the number of jobs the occupation provided in 2004 (nationwide and Pennsylvania) and the key industries where these jobs are found. When significant, the geographic distribution of jobs and the proportion of part-time (less than 35 hours a week) and self-employed workers in the occupation are mentioned.

Job Outlook

The long-term job outlook is a factor to consider when deciding on an occupation. This section shows anticipated growth or decline for an occupation in Pennsylvania by comparing actual 2004 employment figures with projected employment for 2014. In addition, this section describes the factors that will result in growth or decline in the number of jobs. In some cases, the *Handbook* mentions that an occupation is likely to provide numerous job openings or relatively few openings. Occupations that are large and have high turnover, such as cashiers and retail sales positions, generally provide the most job openings. Susceptibility to layoffs due to imports, slowdowns

in economic activity, technological advancements, or budget cuts are also addressed in this section. For example, employment of construction craft workers is sensitive to slowdowns in construction activity, while employment of government workers is sensitive to budget cuts.

Earnings

This section discusses typical earnings and how workers are compensated—annual salaries, hourly wages, commissions, piece rates, tips, or bonuses. Within every occupation, earnings vary by experience, responsibility, performance, tenure, and geographic area. Earnings data are from the Occupational Employment Statistics annual survey of Pennsylvania employers. Average hourly earnings for entry-level and experienced-level workers are now available as well.

Benefits account for a significant portion of total compensation costs to employers. Benefits such as paid vacation, health insurance, and sick leave may not be mentioned because they are so widespread. Though not as common as traditional benefits, employers may offer flexible hours and profit sharing plans to attract and retain highly qualified workers. Less common benefits also include childcare, tuition for dependents, housing assistance, summers off, and free or discounted merchandise or services.

Training, Other Qualifications and Advancement

Knowing what kinds of training or education are required for a job is an important part of career planning. This section describes the most significant sources of training, including the training preferred by employers, the typical length of training, and advancement possibilities. Job skills are sometimes acquired through high school, informal on-the-job training, formal training (including apprenticeships), the Armed Forces, home study, hobbies, or previous work experience. For example, sales experience is particularly important for many sales jobs, which may not require any education beyond high school. Many professional and technical jobs, on the other hand, require formal post-secondary education—vocational or technical training, or college, postgraduate, or professional education.

Also discussed here are the qualifications usually expected of job applicants, as well as opportunities for advancement or promotion. Some occupations require certification or licensing to enter the field, to advance, or to practice independently. Certification or licensing generally involves completing courses and passing examinations. Increasingly, many occupations have continuing education or skill improvement requirements to keep up with the changing economy or to improve advancement opportunities.

Related Occupations

Occupations involving similar duties, skills, interests, education, and training are listed.

Sources of Additional Information

No single publication can completely describe all aspects of an occupation. Thus, the *Handbook* lists mailing addresses for associations, government agencies, unions, and other organizations that can provide occupational information. In some cases, toll free phone numbers and Internet addresses also are listed. Links to non-BLS Internet sites are provided for your convenience and do not constitute an endorsement.

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Education and Training

Education and Training Introduction

This section of the Handbook explores careers in the Education and Training career cluster. Occupations included here are college and university faculty as well as secondary, elementary, kindergarten, preschool and special education teachers. Also included are education administrators, counselors, teacher assistants and librarians.

Education employs some of the most highly educated workers in the labor force. College and university faculty generally require the highest level of educational attainment among occupations in this career cluster. These postsecondary positions normally require a doctoral degree in order to obtain full-time status. As a result, full-time postsecondary teachers have the highest earnings among all teachers.

School teachers are projected to have the most annual openings within this cluster for the foreseeable future. Significant growth is expected in areas such as preschool services as students are introduced to the school environment at younger ages. Special education teachers are expected to see growth as well. These teachers are expected to have a bachelor's degree, complete with an approved teacher-training program, and must obtain a teaching license. Earning in these occupations are higher than the average.

In addition to the teaching professions, there are positions in education administration. These include principals and assistant principals, academic deans, and other school administrators. Former teachers and faculty are the most likely candidates for these positions, although sitting administrators commonly move to similar or higher status jobs at other schools.

Educational support occupations are also expected to grow. Teacher assistant positions should be plentiful. Typically, they do not require a college education, but the salary is also below average for education occupations. Library occupations (including librarian, library assistants, and library technicians) should also see growth in the years ahead.

Overall, the job outlook for the occupations above is bright. The majority of education positions are growing faster than the average of all occupations combined. Growth in education, combined with the above-average age of current education employees, will create ample opportunities in the coming years for persons aspiring to enter this field.

Education and Training Occupations

The occupations in green are either new to this edition or have had a name change since the last.

Adult & Vocational Education Teachers

Library Assistants

Childcare Workers

Library Technicians

College & University Faculty

Special Education Teachers

Education Administrators

Teachers

Educational & Vocational Counselors

Teacher Assistants

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Adult & Vocational Education Teachers

SOC CODES: 25-1194, 25-2023, 25-2032, 25-3011 and 25-3021

Significant Points

- Training requirements can vary with subject and employer.
- Opportunities should be best for those seeking part-time positions.

Nature of the Work

- Adult & vocational education teachers integrate academic and vocational curriculums so that adult students can obtain a variety of skills. Teachers work in one of four main areas.
 - Adult vocational-technical education teachers* provide instruction for occupations that do not require a college degree.
 - Adult remedial education teachers* conduct basic education courses.
 - Adult education teachers* help workers update their job skills and adapt to new technologies.
 - Adult continuing education teachers* direct personal enrichment courses.
- Classes may be taught in classrooms or the workplace.
- In addition to teaching, adult & vocational education teachers also prepare lessons and grade papers. They may also attend meetings.

Working Conditions

- Classes vary in length from half-day workshops to semester-long courses. In order to accommodate student schedules, many institutions also offer evening and weekend courses. Part-time work is very common.
- Most adult & vocational education teachers work in classroom settings. However, some are consultants who teach classes at the job site.
- Because they work with adult students, these teachers do not encounter the same behavioral or social problems associated with younger students.

Employment

- Adult & vocational education teachers held about 469,000 jobs in 2004 in the United States and approximately 21,550 jobs in Pennsylvania.
- Over 63 percent were employed with educational institutions, primarily elementary and secondary schools. About 8 percent worked for religious organizations. About 1 in 9 were self-employed.
- The following table includes the industries that employed the most adult & vocational education teachers in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Elementary & Secondary Schools	6,520	30.3%
Self-Employed	2,390	11.1%
Other Schools & Instruction	2,080	9.6%
Junior Colleges	1,760	8.1%
Religious Organizations	1,630	7.5%

Job Outlook

- Employment of adult & vocational education teachers in Pennsylvania is expected to grow from approximately 21,550 in 2004 to approximately 24,180 in 2014. Adult & vocational education teachers can expect about 263 openings due to growth and about 404 replacement openings for approximately 667 total annual openings.
- Employment growth will be stimulated by a need to train young adults for entry-level jobs. It will further increase as experienced workers seek training to learn new technologies or switch fields.
- Opportunities should be best for those seeking part-time positions.
- Because adult education programs receive government funding, they may be affected by budgetary changes.

Earnings

- In Pennsylvania, adult & vocational education teachers averaged \$36,300 to \$52,000 annually in 2005. The entry-level earnings were between \$16,600 and \$37,300, while experienced adult & vocational education teachers were paid anywhere from \$43,100 to \$59,100.
- The following table includes the average hourly, entry level, and experienced level wages in 2005 for adult & vocational education teachers in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Vocational Education Teachers, Postsecondary	\$41,290	\$26,840	\$48,510
Vocational Education Teachers, Middle School	\$46,850	\$29,150	\$55,710
Vocational Education Teachers, Secondary School	\$51,970	\$37,870	\$59,020
Adult Literacy, Remedial Education & GED Teachers	\$36,690	\$23,690	\$43,190
Self-Enrichment Education Teachers	\$36,350	\$16,660	\$46,200

Training, Other Qualifications and Advancement

Training requirements can vary with subject and employer. An advanced degree may be required to teach courses that can be applied towards a four-year degree. However, most vocational teachers are employed with junior or community colleges and do not have an advanced degree. Instead, they draw on their work experience and practical knowledge. Basic education and literacy instructors usually have a bachelor's degree and teacher certification. For self-enrichment classes, appropriate work experience is often sufficient.

In order to maintain their certification, adult and vocational education teachers update their skills through continuing education. Some attend seminars, conferences or graduate courses. Others return to work in the industry. An ongoing dialogue must be maintained with businesses to determine which skills are currently needed in the workplace.

Aspiring adult & vocational education teachers should enjoy working with people. They must have the ability to motivate students and make them feel comfortable. Strong communication and interpersonal skills are very important. Patience and understanding are needed in order to make students feel comfortable and to help them understand concepts.

Adult & vocational education teachers may be promoted to administrative positions. However, these positions usually require an advanced degree.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of adult & vocational education teachers include counselors, school administrators, schoolteachers, public relations specialists, employee development specialists, and social workers.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Association for Career and Technical Education, 1410 King St., Alexandria, VA 22314.
Internet: <http://www.acteonline.org>

Childcare Workers

SOC CODE: 39-9011

Significant Points

- A high school diploma and minimal experience are adequate for most jobs.
- Qualified applicants should have little trouble finding work.

Nature of the Work

- **Childcare workers** attend to the basic health and educational needs of children under the age of 6. They play a vital role in developing the skills a child will need throughout life.
 - Babysitters work in a private household for short periods of times and are usually compensated on an hourly basis.
 - Nannies take care of children from birth to age 10 or 12. They may tend to early education, nutrition, health and other needs.
- To ensure a balanced program, childcare workers plan activities that stimulate a child's physical, emotional, intellectual and social growth. These activities unite individual and group play as well as active and quiet time.
- Although most of the day is spent working with children, informal meetings and scheduled conferences are held with parents and guardians.

Working Conditions

- Work schedules of childcare workers can vary greatly. While some providers are open year round, others only operate during the school year. Full-time and part-time employees work staggered shifts so that the entire workday schedule is covered.
- Childcare can be a very rewarding career. New activities and challenges mark each day, so the work is never routine. However, much of the day is spent standing, bending and lifting children. This can be physically and emotionally challenging to some people.
- To ensure that children receive proper supervision, State or local regulations may require a certain ratio of workers to children.

Employment

- Childcare workers held about 1.3 million jobs in 2004 in the United States and approximately 29,520 jobs in Pennsylvania.
- Over 29 percent worked in child day care centers and preschools. Others were employed with educational institutions and religious organizations. About 1 in 4 were self-employed.
- The following table includes the industries that employed the most childcare workers in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Child Day Care Services	8,600	29.1%
Self-Employed	7,320	24.8%
Elementary & Secondary Schools	2,590	8.8%
Other Residential Care Facilities	2,380	8.1%
Religious Organizations	1,790	6.1%

Job Outlook

- Employment of childcare workers in Pennsylvania is expected to grow from approximately 29,520 in 2004 to approximately 33,010 in 2014. Childcare workers can expect about 349 openings due to growth and about 804 replacement openings for approximately 1,153 total annual openings.
- Demand for childcare workers will increase as the proportion of children enrolled in childcare programs increases. However, employment growth will still be much slower than it has been over the last two decades.
- Qualified individuals should have little trouble finding and keeping a job.

Earnings

- Average hourly earnings of childcare workers in Pennsylvania were \$17,630 in 2005. The entry-level rate in 2005 was \$12,710 while an experienced childcare worker made \$20,100.
- Although benefits are usually minimal, many employers do offer free or discounted childcare. Some employers do provide full benefit packages, which include health insurance and paid vacations.

Training, Other Qualifications and Advancement

The training and qualifications required of childcare workers vary widely. Each State has its own licensing requirements that regulate childcare training, ranging from a high school diploma to a college degree in childhood development or early childhood education. However, most State requirements are minimal. In fact, childcare workers can often obtain employment with a high school degree and little or no experience.

Many employers prefer to hire applicants with previous work experience, coursework in child development or nationally recognized credentials. Local governments, private firms, and publicly funded programs may have more demanding training and education requirements.

Childcare workers should be alert and enthusiastic people, who have high levels of energy and physical stamina. Art, music, drama and storytelling skills are very important. When handling disruptive children, the discipline should be fair but firm. Successful childcare employees are able to communicate effectively with children, their parents and other child-care workers.

Without additional education, opportunities for advancement are limited. Some experienced childcare workers advance to supervisory or administrative positions in larger institutions. Others take jobs with resource and referral agencies. Some open their own childcare businesses.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of childcare workers include teacher assistants, preschool teachers, kindergarten teachers, elementary school teachers, child psychologists, and early childhood program directors.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Center for the Child Care Workforce, 733 15th St. NW, Suite 1037, Washington, DC 20005-2112. Internet: <http://www.ccw.org>
- National Child Care Information Center, 243 Church St. NW, 2nd floor, Vienna, VA 22180. Internet: <http://www.nccic.org>
- National Childcare Association, 1016 Rosser St., Conyers, GA 30012. Internet: <http://www.nccanet.org>
- International Nanny Association, 191 Clarksville Rd., Princeton Junction, NJ 08550-3111. Internet: <http://www.nanny.org>

College & University Faculty

SOC CODES: 25-1011, 25-1021, 25-1022, 25-1031, 25-1032, 25-1041, 25-1042, 25-1043, 25-1051, 25-1052, 25-1053, 25-1054, 25-1061, 25-1062, 25-1063, 25-1064, 25-1065, 25-1066, 25-1067, 25-1071, 25-1072, 25-1081, 25-1082, 25-1111, 25-1112, 25-1113, 25-1121, 25-1122, 25-1123, 25-1124, 25-1125, 25-1126, 25-1192, 25-1193 and 25-1199

Significant Points

- Most faculty positions require a doctoral degree.
- Keen competition is expected for full-time positions at four-year institutions.
- University faculty members spend a great deal of time performing research.

Nature of the Work

- *College & university faculty* teach courses and lead seminars for undergraduate and graduate students. Based on their subject or field, faculty members are usually organized into departments or divisions.
- Computers and other technologies are increasingly used as teaching aids in the classroom.
- Within universities, most teachers spend a significant part of their time performing research. However, faculty members at two-year colleges spend little time performing research and often have a heavier teaching load.
- To keep abreast of developments in their field, college & university faculty read current literature, talk with colleagues, participate in professional conferences and perform their own research.

Working Conditions

- College & university faculty must be present at classes and faculty meetings. They must also maintain office hours outside of class. On average, this requires about 15 to 22 hours per week. Beyond that, faculty members are essentially free to determine their own work schedules. Evening and weekend hours may be required, particularly at institutions that have a large enrollment of part-time students.
- Most educational institutions only require faculty to work nine months of the year. This gives faculty members a chance to teach additional courses, perform research, travel, or pursue other non-academic interests.
- Part-time faculty members spend little time on campus. In fact, they often teach at more than one college.

Employment

- College & university faculty held about 1.6 million jobs in 2004 in the United States and approximately 67,920 jobs in Pennsylvania.
- Over 96 percent were employed with educational institutions, primarily colleges, universities and junior colleges. Others worked for religious organization.

Job Outlook

- Employment of college & university faculty in Pennsylvania is expected to grow from approximately 67,920 in 2004 to approximately 72,270 in 2014. College & university faculty can expect about 435 openings due to growth and about 1,536 replacement openings for approximately 1,9693 total annual openings.
- Keen competition is expected for full-time, tenure-track positions at four-year institutions. Opportunities will be best for those applicants who are willing to work part-time. Opportunities are primarily limited to those who specialize in a field needed at the institution.
- Employment prospects will be best in those fields that also offer attractive non-academic job opportunities.

Earnings

- In Pennsylvania, college & university faculty averaged \$44,500 to \$83,600 annually in 2005. Entry-level faculty earned between \$21,100 and \$56,200, while experienced faculty were paid anywhere from \$56,200 to \$104,000. Across all experience levels, postsecondary recreation and fitness teachers earned the lowest wages.
- Wage information for specific college & university faculty classifications is available through the Pennsylvania Department of Labor & Industry, Center for Workforce Information & Analysis.
- Beyond their base salary, most college & university faculty earn additional income from consulting, researching, publication writing and other employment.
- Full-time faculty members enjoy unique benefits, such as health insurance, tuition waivers, housing allowances, travel reimbursements and paid sabbatical leaves. Part-time faculty members usually receive fewer benefits.

Training, Other Qualifications and Advancement

Most college & university faculty members are hired as instructors or assistant professors. Four-year institutions usually prefer to hire applicants with a doctoral degree although they may select individuals with a master's degree for certain disciplines or part-time positions. Master's degree holders may also find employment with two-year colleges. However, increasing competition allows schools to be more selective in their hiring practices. As a result, applicants with a master's degree may find it difficult to obtain employment.

On average, doctoral programs take six to eight years of full-time study beyond the bachelor's degree level to complete. During their studies, many candidates elect to specialize in a particular discipline area. Educational programs include approximately 20 courses plus comprehensive examinations in all areas of their field. Before being awarded their doctoral degree, students must also complete a dissertation – a written report on original research in their field. In certain fields of study, such as the natural sciences, candidates spend an additional two years on post-doctoral research before accepting faculty positions.

A major step in the academic career of college & university faculty is the attaining of tenure. Professors who are tenured cannot be fired without just cause and due process. In addition, tenure protects the faculty member's academic freedom. Newly hired faculty sign a contract to serve a particular institution for a certain period of time, usually seven years. At the end of that period, the employing institution reviews the faculty member's record of teaching, research, and overall contributions. Tenure is granted if the review is favorable. Those denied tenure are usually required to leave the institution.

The number of tenure-track teaching positions is expected to decline as institutions seek flexibility in dealing with financial matters and changing student interests. In fact, some schools have already limited the percentage of faculty who can be tenured. Instead, employers will rely on limited term contracts and part-time faculty. A limited term contract allows an institution to hire prospective faculty for a short period of time. At the end of the contract period, faculty members may be terminated or offered a contract extension. Institutions are not obligated to grant tenure to professors with limited term contracts.

Experienced faculty can be promoted to administrative and managerial positions, such as department head, dean or president. In most situations, a doctoral degree is required for promotion.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of college & university faculty include elementary school teachers, secondary school teachers, librarians, counselors, writers, consultants, lobbyists, training specialists, employee development specialists, policy analysts and scientists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Association of American Colleges and Universities, 1818 R St. NW, Washington, DC 20009. Internet: <http://www.aacu-edu.org>
- Association for Career and Technical Education, 1410 King St., Alexandria, VA 22314. Internet: <http://www.acteonline.org>

Education Administrators

SOC CODES: 11-9031, 11-9032, 11-9033 and 11-9039

Significant Points

- An advanced college degree is required.
- Competition will be keen for positions in postsecondary institutions.
- Prospects will be best for highly educated candidates who are willing to relocate.

Nature of the Work

- Education administrators provide direction, leadership and management of educational activities. They set goals, establish policies, prepare budgets and develop academic programs. In addition, they often supervise managers, support staff, teachers, counselors, librarians and coaches.

Principals manage elementary and secondary schools. Duties include visiting classrooms, observing teachers, reviewing instructional objectives, and examining learning materials. Close attention is paid to the concerns of parents, teachers and other members of the community.

Assistant principals aid the principal in the overall administration of the school. They usually handle discipline, attendance, extra-curricular programs and student safety.

Central office administrators plan, evaluate, standardize and improve curriculums and teaching techniques in all of the public schools in their jurisdiction.

College or university department heads perform the administrative duties that are required to operate their specific department, such as science or mathematics.

- Other education administrators are responsible for student services such as admissions, financial aid, health services and housing issues. In smaller schools, these workers may also counsel students.

Registrars are custodians of students' records. They register students, prepare transcripts, evaluate academic records, collect tuition and analyze enrollment statistics.

Admissions directors manage the process of recruiting, evaluating and admitting students.

Financial aid directors oversee scholarship, fellowship and loan programs.

Directors of student activities plan and arrange social, cultural and recreational activities. They also assist student-run organizations and may conduct new student orientation.

Athletic directors plan and direct intramural and intercollegiate athletic activities.

Working Conditions

- Education administrators usually work more than 40 hours per week. Occasional evening and weekend hours may be required to oversee certain school activities. Although some administrators are employed year round, most work only 10 or 11 months per year.
- This occupation can be fast-paced and stimulating. It can also be stressful and demanding.
- Some travel may be required in order to attend meetings and conferences.

Employment

- Education administrators held about 441,700 jobs in 2004 in the United States and approximately 18,530 jobs in Pennsylvania.
- Over 80 percent were employed with educational institutions – primarily elementary and secondary schools (47 percent) and colleges and universities (28 percent). Other worked in day care centers or religious organizations.

Job Outlook

- Employment of education administrators in Pennsylvania is expected to grow from approximately 18,530 in 2004 to approximately 20,690 in 2014. Education administrators can expect about 216 openings due to growth and about 460 replacement openings for approximately 676 total annual openings.
- Keen competition is expected for jobs at postsecondary institutions. However, applicants will have many opportunities at the elementary and secondary school levels.
- Because relatively few job openings exist, only the most highly qualified applicants are selected. Prospects will be best for those with appropriate education and a willingness to relocate.
- Budget constraints are expected to moderate employment growth in this occupation.

Earnings

- In Pennsylvania, education administrators averaged \$40,800 to \$78,000 annually in 2005. The entry-level earnings were between \$25,000 and \$53,900, while experienced education administrators were paid anywhere from \$48,600 to \$92,900.
- The following table includes the average hourly, entry level, and experienced level wages in 2005 for education administrators in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Education Administrators, Preschool & Child Care Center	\$40,800	\$25,040	\$48,680
Education Administrators, Elementary & Secondary School	\$77,980	\$53,890	\$90,030
Education Administrators, Postsecondary	\$75,060	\$39,510	\$92,840
Education Administrators, Other	\$60,770	\$42,210	\$70,050

Training, Other Qualifications and Advancement

Most education administrators begin their careers in related occupations. As a result, their educational background and experience levels can vary considerably. To be considered for an open administrator position, workers must first prove themselves in their current job. In addition, most individuals are expected to acquire a master's or doctoral degree in education administration, education supervision, student affairs or in the field of their specialty. Although a bachelor's degree may be sufficient for employees of private schools, candidates who have obtained an advanced college degree are still preferred.

Master's and doctoral degrees in education administration, education supervision, and college student affairs are available through many colleges and universities. Programs include courses in a wide variety of subjects, including school management, school finance, curriculum development and human relations.

Several education administrator positions require certification. To obtain certification, applicants must meet the national standards that have been established. In many instances, attendance at continuing education classes is needed to maintain certification.

When hiring education administrators, employers look for individuals who are determined, confident, and innovative. The ability to make sound decisions and organize work efficiently is essential. Aspiring administrators must be capable of motivating and leading other people. Since education administrators interact with many different people, they need strong communication and interpersonal skills. Familiarity with computer technology is a plus. A background in mathematics or statistics may be beneficial for financial aid directors and registrars.

Education administrators can advance by moving up the administrative ladder or transferring to larger school systems. They may be promoted to positions such as school superintendent or university president.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of education administrators include health services managers, human resource managers, administrative managers, office managers, park managers, museum directors, library directors, organization executives, teachers, and school counselors.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Association of School Administrators, 801 N. Quincy St., Suite 700, Arlington, VA 22203-1730. Internet: <http://www.aasa.org>
- The National Association of Elementary School Principals, 1615 Duke St., Alexandria, VA 22314-3483. Internet: <http://www.naesp.org>
- National Association of Secondary School Principals, 1904 Association Dr., Reston, VA 20191-1537. Internet: <http://www.nassp.org> or <http://www.principals.org>
- American Association of Collegiate Registrars and Admissions Officers, One Dupont Circle NW, Suite 520, Washington, DC 20036-1171. Internet: <http://www.aacrao.org>
- National Association of Student Personnel Administrators, 1875 Connecticut Ave. NW, Suite 418, Washington, DC 20009. Internet: <http://www.naspa.org>
- Educational Research Service, 2000 Clarendon Blvd, Arlington, VA 22201-2908. Internet: <http://www.ers.org>

Educational & Vocational Counselors

SOC CODE: 21-1012

Significant Points

- A master's degree is required for most counselor positions.
- Employment growth will be stimulated by increased school enrollments and expanded job responsibilities.
- Licensure or certification is required to work in Pennsylvania.

Nature of the Work

- Educational & vocational counselors assist people with important educational and career decisions. Specific duties will depend on the individuals they serve and the settings in which they work.
- School counselors help students evaluate their abilities, interests, and talents to develop realistic academic and career goals. They also offer advice on social, behavioral and personal problems.

Elementary school counselors observe younger children and confer with their teachers and parents to evaluate their strengths and identify potential problems

High school counselors provide information about colleges, vocational-technical schools and apprenticeship programs. They may help students develop job search skills.

College counselors assist students and alumni with career development and job-hunting techniques.

- Vocational counselors explore and evaluate a client's education, training, work history, interests, skills and personality traits to help them make career decisions. They work with individuals to develop job search skills, such as resume writing and interviewing techniques.

Working Conditions

- Educational counselors usually have the same hours as teachers. Traditionally, they have worked a normal school year with a summer vacation. As responsibilities grow, many educational counselors are now employed on 10 or 11-month contracts.
- Most vocational counselors work a standard 40-hour week. Evening hours may be required to counsel clients who work during the day.
- Since privacy is essential, most educational & vocational counselors have private offices.

Employment

- Educational & vocational counselors held about 248,500 jobs in 2004 in the United States and approximately 11,160 jobs in Pennsylvania.
- About 68 percent were employed with educational institutions, principally in elementary and secondary schools. Others worked for firms that offer vocational rehabilitation services.
- The following table includes the industries that employed the most educational & vocational counselors in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Elementary & Secondary Schools	5,280	47.3%
Colleges & Universities	1,600	14.3%
Vocational Rehabilitation Services	830	7.5%
State Government	740	6.6%

Job Outlook

- Employment of educational & vocational counselors in Pennsylvania is expected to grow from approximately 11,160 in 2004 to approximately 12,500 in 2014. Educational & vocational counselors can expect about 134 openings due to growth and about 255 replacement openings for approximately 389 total annual openings.
- Because of increasing school enrollments and expanded responsibilities, educational & vocational counselors can expect significant employment growth. However, job growth may be dampened by budgetary constraints.

- Opportunities should be very good for vocational counselors in the private job-training sector. The services provided by these counselors will be in great demand by workers who are displaced, seeking a different career, re-entering the work force or hoping to upgrade their skills.

Earnings

- Average annual earnings of educational & vocational counselors in Pennsylvania were \$45,440 in 2005. The entry-level wage in 2005 was \$27,470 while experienced counselors made \$54,420.
- During summer breaks, educational counselors can earn additional income from other jobs.

Training, Other Qualifications and Advancement

Although a bachelor's degree may be sufficient for employment as an educational or vocational counselor, employers generally prefer to hire applicants who have earned a master's degree. In fact, many employers offer work-study programs that allow employed counselors to earn a graduate degree while in the workforce. As a result, most individuals continue their studies and obtain a master's degree in education, school counseling, student affairs or career counseling.

Graduate-level programs are offered through many colleges and universities. An accredited program consists of at least two years of full-time study, including a period of supervised clinical experience. Courses in employment counseling, job development, psychology, education, or social work can be beneficial.

All educational counselors must obtain school certification in order to work in Pennsylvania. Applicants must have a master's degree and about two to five years of experience. Licenses are issued to those individuals who pass the written examination. Counselors may be exempted from the state examination if they have already received voluntary certification from the National Board for Certified Counselors (NBCC). To maintain certification, counselors must re-take the examination every five years or complete 100 hours of acceptable continuing education in the same period of time.

A strong desire to help others is essential for aspiring educational and vocational counselors. The ability to inspire respect and trust is also important. Successful counselors can work independently or as part of a team. A high level of physical and emotional energy is needed to deal with the wide array of problems that are encountered.

Educational & vocational counselors may be promoted to supervisory or director positions. To increase their opportunities for advancement, individuals may transfer to larger schools. With additional training, they can become counselor educators, counseling psychologists or school administrators. Some counselors go to work for the State Department of Education. Others transfer into research, consulting or teaching positions.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of educational & vocational counselors include student affairs workers, teachers, personnel workers, training specialists, employee development specialists, clergy, human services workers, social workers, psychologists, psychiatrists, psychiatric nurses, and occupational therapists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Counseling Association, 5999 Stevenson Ave., Alexandria, VA 22304-3300.
Internet: <http://www.counseling.org>
- National Board for Certified Counselors, Inc., 3 Terrace Way, Suite D, Greensboro, NC 27403-3660.
Internet: <http://www.nbcc.org>

Librarians

SOC CODE: 25-4021

Significant Points

- A master's degree in library science is required for most positions.
- Job prospects should be best in rural areas.

Nature of the Work

- **Librarians** assist people in finding information and using it effectively. In addition, they may coordinate programs such as storytelling for children and literacy skills for adults.
- Administrative duties may include negotiating contracts for new materials, supervising library personnel, performing fundraising events and preparing budgets.
- Employment opportunities exist within government agencies, large corporations, law firms, advertising agencies, museums, medical centers, hospitals, religious organizations and research laboratories. These organizations often maintain internal libraries that house the company's information resources.
- Computer and information systems skills are required to develop and operate computerized databases that allow librarians to quickly locate any requested information.

Working Conditions

- Most librarians work normal business hours. In schools, they work the same schedules as teachers. Part-time work is also common. Evening, weekend, and holiday shifts may be required.
- Much of the day is spent behind a desk. Eyestrain and headaches may occur from excessive use of computers.
- Overall, this occupation can be very rewarding. Individuals may feel stress when dealing with deadlines and heavy workloads.

Employment

- Librarians held about 159,300 jobs in 2004 in the United States and approximately 6,770 jobs in Pennsylvania.
- Over 64 percent were employed with educational institutions, mainly elementary and secondary schools. Others worked for public libraries or local government agencies.
- The following table includes the industries that employed the most librarians in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Elementary & Secondary Schools	2,700	39.9%
Colleges & Universities	1,520	22.5%
Local Government	850	12.5%
Other Information Services	740	11.0%

Job Outlook

- Employment of librarians in Pennsylvania is expected to grow from approximately 6,770 in 2004 to approximately 7,900 in 2014. Librarians can expect about 112 openings due to growth and about 162 replacement openings for approximately 274 total annual openings.
- Employment growth will be offset by the increased use of computerized information systems.
- Keen competition is expected as the number of qualified applicants outpaces the number of job openings. Job prospects should be best in rural areas.
- Opportunities will be better in non-traditional settings, such as private corporations and consulting firms. For example, companies may hire librarians to set up their information on the Internet.

Earnings

Average annual earnings of librarians in Pennsylvania were \$47,330 in 2005. The entry-level wage in 2005 was \$26,790 while an experienced librarian made \$57,590.

Training, Other Qualifications and Advancement

A master's degree in library science (MLS) is required for most librarian positions. Although many colleges and universities offer programs in library science, very few schools have been accredited by the American Library Association. In general, employers prefer to hire graduates of an accredited program.

Before applying to an MLS program, aspiring librarians must obtain a bachelor's degree in a liberal arts field. The MLS program itself lasts one to two years and provides students with a general preparation for library work. However, some students specialize in a particular area, such as reference or technical services. Computer-related course work is an increasingly important part of an MLS program.

Librarians who work in public schools must be certified. Certification may also be required for public librarians in municipal, county or regional library systems. Qualified applicants are tested for competency in basic skills and subject matter proficiency. To maintain their certification and keep abreast of changing technologies, librarians must participate in continuing education classes.

With experience, librarians may be promoted to department head, library director or chief information officer positions. Additional education, such as a doctoral degree in library and information science, may be required for college faculty positions.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of librarians include archivists, information scientists, museum curators, research analysts, information brokers, records managers, teachers, database specialists, webmasters, web developers, and systems analysts.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Library Association, 50 E. Huron St., Chicago, IL 60611. Internet: <http://www.ala.org>
- Special Libraries Association, 1700 18th St. NW, Washington, DC 20009-2514. Internet: <http://www.sla.org>
- Association for Library and Information Science Education, 1009 Commerce Park Dr., Suite 150, P.O. Box 4219, Oak Ridge, TN 37830. Internet: <http://www.alise.org>
- American Association of Law Libraries, 53 W. Jackson Blvd., Suite 940, Chicago, IL 60604. Internet: <http://www.aallnet.org>
- Medical Library Association, 65 E. Wacker Pl., Chicago, IL 60601-7298. Internet: <http://www.mlanet.org>

Library Assistants

SOC CODE: 43-4121

Significant Points

- A high school diploma is required for most positions.
- Flexible work schedules are appealing to retirees, students and other individuals seeking part-time work.

Nature of the Work

- **Library assistants** organize library resources and make them available to users. They may register patrons, lend resources, sort returned items and put materials back in their designated areas.
- In addition to their lending and collecting duties, library assistants also compile a list of overdue materials, compute fines and send out delinquency notices.

Working Conditions

- Most library assistants work normal business hours. In educational institutions, they work the same schedules as teachers. Flexible scheduling and part-time work is common. Evening and weekend shifts may be necessary during peak times.
- Library assistants spend a lot of time standing, stooping, bending and reaching. Eyestrain and headaches may occur from excessive use of computer terminals.

Employment

- Library assistants held about 108,500 jobs in 2004 in the United States and around 4,760 jobs in Pennsylvania.
- Over 43 percent were employed with educational institutions. About one-third worked in public libraries.
- The following table includes the industries that employed the most library assistants in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Other Information Services	1,500	31.5%
Colleges & Universities	1,110	23.4%
Local Government	1,040	21.8%
Elementary & Secondary Schools	780	16.5%

Job Outlook

- Employment of library assistants in Pennsylvania is expected to grow from approximately 4,760 in 2004 to approximately 5,380 in 2014. Library assistants can expect about 62 openings due to growth and about 193 replacement openings for approximately 255 total annual openings.
- Flexible work schedules are appealing to retirees, students, and other individuals seeking part-time work.
- In an effort to cut costs, companies will continue to hire library assistants instead of librarians.
- Budgetary concerns could dampen employment growth within educational institutions.

Earnings

Average annual earnings of library assistants in Pennsylvania were \$20,600 in 2005. The entry-level wage in 2005 was \$13,820 while an experienced library assistant made \$23,980.

Training, Other Qualifications and Advancement

When filling library assistant positions, employers prefer to hire computer-literate applicants who have a high school diploma or equivalent. Necessary skills are often acquired through on-the-job training although some classroom instruction may be necessary for specific computer software. Formal training programs are offered in many high schools, business schools and community colleges.

Aspiring library assistants should be detail-oriented. To avoid making errors, these workers must be careful and orderly. Discreetness and trustworthiness are important traits because these individuals frequently handle confidential information. Strong interpersonal skills are essential when interacting with the public.

Advancement opportunities usually take the form of additional responsibilities and increased pay. Some workers transfer to closely related occupations. With appropriate experience and education, some library assistants become library technicians or librarians. Opportunities for advancement are usually greater in larger libraries.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of library assistants include tellers, statistical clerks, receiving clerks, medical record clerks, hotel desk clerks, credit clerks, and ticket agents.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Library Association, 50 E. Huron St., Chicago, IL 60611. Internet: <http://www.ala.org>
- Council on Library/Media Technology, 100 W. Broadway, Columbia, MO 65203. Internet: <http://colt.ucr.edu>

Library Technicians

SOC CODE: 25-4031

Significant Points

- Training requirements vary greatly by organization.
- Over 41 percent were employed with local government.

Nature of the Work

- *Library technicians* help librarians acquire, prepare, and organize material. They may also assist users in finding information. Others operate and maintain audio-visual equipment, such as projectors.
- The increasing use of new technologies, such as the Internet and automated databases, will expand and evolve the duties of library technicians.
- Employment opportunities exist within government agencies, large corporations, law firms, advertising agencies, museums, medical centers, hospitals, religious organizations, and research laboratories. These organizations often maintain internal libraries that house the company's information resources.

Working Conditions

- Most library technicians work normal business hours. In schools, they work the same schedules as teachers. Evening, weekend, and holiday shifts may be necessary during peak times.
- Work is usually performed under the direct supervision of a librarian. However, certain tasks require technicians to work independently.
- Although many tasks are interesting and challenging, others are repetitive and boring.
- Library technicians spend most of the day behind a desk. Eyestrain and headaches may occur from excessive use of computer terminals.

Employment

- Library technicians held about 122,100 jobs in 2004 in the United States and around 4,920 jobs in Pennsylvania.
- Over 41 percent were employed with local government. Others worked for educational institutions, such as elementary and secondary schools, and public libraries.
- The following table includes the industries that employed the most library technicians in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Local Government	2,020	41.2%
Colleges & Universities	960	19.6%
Elementary & Secondary Schools	760	15.3%
Other Information Services	740	15.1%

Job Outlook

- Employment of library technicians in Pennsylvania is expected to grow from approximately 4,920 in 2004 to approximately 5,360 in 2014. Library technicians can expect about 44 openings due to growth and about 182 replacement openings for approximately 226 total annual openings.
- The increasing use of automation is expected to spur job growth among library technicians.
- Budgetary concerns could dampen employment growth within educational institutions.

Earnings

Average annual earnings of library technicians in Pennsylvania were \$24,830 in 2005. The entry-level wage in 2005 was \$16,140 while an experienced library technician made \$29,170.

Training, Other Qualifications and Advancement

Training requirements vary greatly by organization. Some employers choose to hire high school graduates and provide them with on-the-job training. Other companies prefer applicants who have completed some formal

postsecondary training. Regardless of education level, all aspiring library technicians should have strong computer skills. Knowledge of databases, library automation systems, on-line library systems, on-line public access systems and circulation systems is valuable.

An associate's degree program in library technology is offered at some two-year colleges. These programs combine library studies with a general liberal arts education. After graduation, many students take continuing education courses in order to keep abreast of new developments in the field.

Advancement opportunities usually take the form of added responsibilities. With sufficient experience, some library technicians are promoted to supervisory positions and placed in charge of the day-to-day operations of their department.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of library technicians include library assistants, information clerks, record clerks, medical record technicians, and title searchers.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Library Association, 50 E. Huron St., Chicago, IL 60611. Internet: <http://www.ala.org>
- Special Libraries Association, 1700 18th St. NW, Washington, DC 20009-2514. Internet: <http://www.sla.org>
- Council on Library/Media Technology, 100 W. Broadway, Columbia, MO 65203. Internet: <http://colt.ucr.edu>

Special Education Teachers

SOC CODES: 25-2041, 25-2042 and 25-2043

Significant Points

- Certification requirements include a bachelor's degree and completion of a teacher-training program.
- Job prospects should be best in inner city and rural areas.

Nature of the Work

- *Special education teachers* design and modify Individual Education Program (IEP) plans for children and youth who have a variety of disabilities. The IEP sets personalized goals and is tailored to the student's individual learning style and ability. These programs are reviewed with the student's parents, school administrators and, often, the student's general education teachers.
- In addition to designing and presenting lessons, special education teachers may assign work and grade papers and homework assignments.
- Another important part of the job is to help students learn the routine skills that will be needed for life after graduation. Some teachers also provide career counseling.
- To aid in the learning process, special education teachers use a variety of specialized equipment such as computers with synthesized speech, interactive educational software programs and audiotapes.

Working Conditions

- Many schools offer year-round programs for special education students. However, most special education teachers work the traditional 10-month school year.
- Individuals who work with infant children usually travel to the child's home.
- Although this occupation can be very rewarding, the work can also be emotionally and physically demanding.
- Special education teachers experience stress from heavy workloads and numerous administrative tasks. A substantial amount of paperwork is required to document each student's progress.

Employment

- Special education teachers held about 441,500 jobs in 2004 in the United States and approximately 18,070 jobs in Pennsylvania.
- Over 95 percent were employed with elementary and secondary schools. A few worked for residential care facilities and other educational facilities.

Job Outlook

- Employment of special education teachers in Pennsylvania is expected to grow from approximately 18,070 in 2004 to approximately 18,430 in 2014. Special education teachers can expect about 35 openings due to growth and about 430 replacement openings for approximately 465 total annual openings.
- Legislative changes, medical advancements and a general growth in population all contribute to the increased demand for special education teachers.
- Although the job outlook varies by geographic area and specialty, employment opportunities should be excellent as many school districts report a shortage of qualified applicants. Job openings will be most plentiful in rural and inner city areas.
- Prospects for special education teachers may be better in particular specialties.

Earnings

- In Pennsylvania, special education teachers averaged \$49,000 to \$52,000 annually in 2005. The entry-level earnings were between \$34,000 and \$37,000, while experienced special education teachers were paid anywhere from \$57,000 to \$60,000.
- Teachers may receive additional pay for coaching sports or leading extracurricular activities. During summer breaks, some teachers work other jobs to earn extra income.
- The following table includes the average hourly, entry level, and experienced level wages in 2005 for special education teachers in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Special Education Teachers, Preschool, Kindergarten & Elementary	N/A	N/A	N/A
Special Education Teachers, Middle School	\$49,940	\$35,400	\$57,210
Special Education Teachers, Secondary School	\$51,790	\$36,150	\$59,620

- No Pennsylvania-specific information was available for preschool, kindergarten or elementary special education teachers. However, the average salary nationwide for these special education teachers in 2005 was \$47,820.

Training, Other Qualifications and Advancement

All special education teachers must be licensed, usually granted by the State Board of Education. Individual licenses exist for several different specialties. General requirements include a bachelor's degree and completion of a teacher-training program. In some cases, a master's degree with a focused specialization is required. Qualified applicants are tested for competency in basic skills and subject matter proficiency. To maintain their licensure, special education teachers must participate in continuing education classes. Additional information about certification is available through the Pennsylvania Department of Education.

Many colleges and universities offer degree programs in special education. These programs, which usually last four or five years, include general and specialized courses. The last year is often spent student teaching in a classroom supervised by a certified teacher.

Aspiring special education teachers should be understanding of students' special needs and accepting of differences in others. Patience and creativity are needed in order to adapt teaching styles to each individual. The ability to motivate students and inspire confidence is essential. Strong communication skills are needed to interact effectively with other teachers, support staff and parents. Applicants who are bilingual may have an advantage.

Experienced individuals can be promoted to supervisor or administrator positions. With an advanced degree, some special education teachers become college instructors.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of special education teachers include school psychologists, social workers, speech pathologists, rehabilitation counselors, adapted physical education teachers, special education technology specialists, occupational therapists, physical therapists, and recreational therapists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- National Clearinghouse for Professions in Special Education, 1110 N. Glebe Rd., Suite 300, Arlington, VA 22201-5704. Internet: <http://www.special-ed-careers.org>
- American Federation of Teachers, 555 New Jersey Ave. NW, Washington, DC 20001. Internet: <http://www.aft.org>
- National Education Association, 1201 16th St. NW, Washington, DC 20036. Internet: <http://www.nea.org>
- National Council for Accreditation of Teacher Education, 2010 Massachusetts Ave. NW, Suite 500, Washington, DC 20036-1023. Internet: <http://www.ncate.org>
- National Board for Professional Teaching Standards, 26555 Evergreen Rd., Suite 400, Southfield, MI 48076. Internet: <http://www.nbpts.org>
- National Association for the Education of Young Children, 1509 16th St. NW, Washington, DC 20036. Internet: <http://www.naeyc.org>
- Recruiting New Teachers, Inc., 385 Concord Ave., Suite 103, Belmont, MA 02478. Internet: <http://www.rntf.org>; <http://www.recruitingteachers.org>
- Council for Professional Recognition, 2460 16th St. NW, Washington, DC 20009-3575. Internet: <http://www.cdacouncil.org/>
- U.S. Department of Education, 400 Maryland Ave., SW, Washington, DC, 20202. Internet: <http://www.ed.gov>

Teachers

SOC CODES: 25-2011, 25-2012, 25-2021, 25-2022 and 25-2031

Significant Points

- Public school teachers must be certified to teach in Pennsylvania.
- Certification requirements include a bachelor's degree and completion of a teacher-training program.
- Job prospects should be best in inner city and rural areas.

Nature of the Work

- Teachers help students understand and apply concepts in various academic subjects. They plan lessons, prepare tests and maintain classroom discipline. In addition, they may oversee study halls and homerooms.
 - Preschool teachers* use small-group lessons and activities to further language and vocabulary development, improve social skills and introduce science and mathematical concepts to children under the age of 5.
 - Kindergarten teachers* use various tools to promote academics, including letter recognition, phonics, numbers and awareness of nature and science, to children from 4 to 6 years old.
 - Elementary school teachers* instruct one class of children in several academic subjects or specialize in one subject for a number of different classes.
 - Middle & secondary school teachers* specialize in a specific subject area and expand on the ideas that were introduced in elementary school. They may also assist students in choosing courses, colleges and careers.
- Computer resources are used to expose students to a vast range of information and promote interactive learning. In addition, teachers use computers to record grades and perform other administrative duties.
- Beyond the classroom, teachers may participate in educational conferences and workshops.

Working Conditions

- Including duties performed outside the classroom, most teachers work more than 40 hours per week. They usually work a standard 10-month school year and have the summer months off. Part-time schedules are more common among preschool and kindergarten teachers.
- Overall, teaching can be a very rewarding career. Individuals may feel stress when dealing with large classes, disruptive students and heavy workloads.
- Teachers may obtain tenure after completing a probationary period of teaching, normally three years. Although tenure does not guarantee a job, it does provide some job security.

Employment

- Teachers held about 3.7 million jobs in 2004 in the United States and around 165,010 jobs in Pennsylvania.
- About 90 percent were employed with educational institutions, primarily elementary and secondary schools. Others worked for child day care centers or religious organizations.

Job Outlook

- Employment of teachers in Pennsylvania is expected to grow from approximately 165,010 in 2004 to approximately 174,810 in 2014. Teachers can expect about 980 openings due to growth and about 3,745 replacement openings for approximately 4,725 total annual openings.
- Employment growth depends on population and the corresponding changes in student enrollments. Additional openings are anticipated as large numbers of teachers retire.
- Opportunities vary by geographic area and subject specialty. Because inner cities and rural areas have difficulty attracting enough teachers, job prospects should continue to be best in these areas.
- Pressures to limit spending may result in fewer job openings. However, pressures to improve the quality of education may offset any decline.

Earnings

- In Pennsylvania, teachers averaged \$22,300 to \$50,200 annually in 2005. The entry-level earnings were between \$14,400 and \$34,100, while experienced teachers were paid anywhere from \$26,200 to \$58,300.
- Teachers may receive additional pay for coaching sports or leading extracurricular activities. During summer breaks, some teachers work other jobs to earn extra income.
- The following table includes the average hourly, entry level, and experienced level wages in 2005 for teachers in Pennsylvania.

Occupational Title	Average Hourly Wage	Entry Level Wage	Experienced Level Wage
Preschool Teachers	\$22,340	\$14,460	\$26,280
Kindergarten Teachers	\$47,010	\$29,030	\$56,000
Elementary School Teachers	\$48,370	\$30,120	\$57,490
Middle School Teachers	\$50,170	\$34,010	\$58,250
Secondary School Teachers	\$48,920	\$32,070	\$57,350

Training, Other Qualifications and Advancement

All public school teachers must be licensed, usually granted by the State Board of Education. However, licensure is not required for those individuals who are employed with private schools. General requirements include a bachelor's degree and completion of a teacher-training program. Qualified applicants are tested for competency in basic skills and subject matter proficiency. To maintain their certification, teachers must participate in continuing education classes. Additional information about teacher certification is available through the Pennsylvania Department of Education.

In order to demonstrate competency beyond that required for a license, teachers may attain professional certification through the National Board for Professional Teaching Standards (NBPTS). Certification is voluntary and available in one of seven different areas, based on the age of the students or subject area. Interested individuals must pass a written examination and present the board with a portfolio of their work. Nationally certified teachers may receive special benefits, such as higher salaries and tuition reimbursements, from their employing school district. In addition, many states allow nationally certified teachers to carry a license from one State to another.

Many colleges and universities offer bachelor's degree programs in education. Generally, 4-year colleges require students to wait until their sophomore year before applying for admission to teacher education programs. Aspiring secondary school teachers most often major in the subject they intend to teach while also taking education courses. In addition to their academic requirements, all students must complete a student-teaching internship. After obtaining a bachelor's degree, interested individuals may enroll in a professional development school – a partnership between a university and elementary or secondary school. These schools offer one-year programs that merge theory with practice and allow students to gain first-hand teaching experience.

Aspiring teachers should be organized and dependable individuals. Patience and creativity are needed in order to adapt teaching styles to individual students. The ability to motivate students and inspire confidence is essential. Effective communication skills are needed to interact with other teachers, support staff and parents.

With additional preparation, kindergarten, elementary, middle and secondary teachers may become school librarians, reading specialists, curriculum specialists or guidance counselors. Some are even promoted to administrator or supervisor positions. However, the number of these positions is limited and competition is usually intense. Preschool teachers usually work their way up from assistant teacher, to teacher, to lead teacher and, finally, director of the center. Those preschool teachers who have a bachelor's degree are also qualified to teach kindergarten through grade 3. Positions teaching these higher grades often result in higher pay too.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of teachers include college and university faculty, education administrators, employment interviewers, librarians, public relations specialists, sales representatives, social workers, and employee development specialists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Federation of Teachers, 555 New Jersey Ave. NW, Washington, DC 20001. Internet: <http://www.aft.org>
- National Education Association, 1201 16th St. NW, Washington, DC 20036. Internet: <http://www.nea.org>
- National Council for Accreditation of Teacher Education, 2010 Massachusetts Ave. NW, Suite 500, Washington, DC 20036-1023. Internet: <http://www.ncate.org>
- National Board for Professional Teaching Standards, 26555 Evergreen Rd., Suite 400, Southfield, MI 48076. Internet: <http://www.nbpts.org>
- National Association for the Education of Young Children, 1509 16th St. NW, Washington, DC 20036. Internet: <http://www.naeyc.org>

- Recruiting New Teachers, Inc., 385 Concord Ave., Suite 103, Belmont, MA 02478.
Internet: <http://www.rnt.org>; <http://www.recruitingteachers.org>
- Council for Professional Recognition, 2460 16th St. NW, Washington, DC 20009-3575.
Internet: <http://www.cdacouncil.org/>
- U.S. Department of Education, 400 Maryland Ave., SW, Washington, DC, 20202. Internet: <http://www.ed.gov>

Teacher Assistants

SOC CODE: 25-9041

Significant Points

- Employers prefer applicants who have some college training.
- Increases in student enrollment levels will stimulate employment growth.
- Part-time work is very common in this occupation.

Nature of the Work

- **Teacher assistants**, also known as *teacher aides* or *paraeducators*, provide instructional and clerical support for classroom teachers allowing the teacher more time to prepare lessons or work with other children. They also supervise children in the classroom, during lunch, at recess or on field trips.
- Using the teacher's lesson plan, most assistants work with students individually or in small groups. Clerical duties may include checking papers, recording grades, duplicating materials, stocking supplies and operating audio-visual equipment.
- Some assistants work extensively with special education students. These workers may attend to the physical needs of a disabled student or provide personal attention to those who speak English as a second language.

Working Conditions

- Most teacher assistants work a traditional 10-month school year and have the summer months off. Part-time work is very common. Even those employed full-time often work less than eight hours per day.
- Although most of the day is spent in a classroom setting, teacher assistants may supervise outdoor recess when the weather allows. Some work in private homes or local government agencies.
- Teaching children can be a very rewarding career. However, working closely with students can also be physically and emotionally exhausting.

Employment

- Teacher assistants held about 1.3 million jobs in 2004 in the United States and approximately 44,240 jobs in Pennsylvania.
- Over 75 percent worked in educational institutions, primarily elementary and secondary schools. Others were employed with child day care centers (11 percent) and religious organizations (6 percent).

Job Outlook

- Employment of teacher assistants in Pennsylvania is expected to grow from approximately 44,240 in 2004 to approximately 49,740 in 2014. Teacher assistants can expect about 550 openings due to growth and about 854 replacement openings for approximately 1,404 total annual openings.
- An overall increase in student enrollments is expected to spur the demand for teacher assistants. Additional demand will result from the increased focus on educational quality and accountability, as required by The No Child Left Behind Act.
- Opportunities will be best for those with at least two years of formal education beyond high school. Individuals who speak a foreign language will also have an advantage.
- Budgetary constraints may affect positions that are financed through Federal Government programs.

Earnings

Average annual earnings of teacher assistants in Pennsylvania were \$19,470 in 2005. The entry-level wage in 2005 was \$13,950 while an experienced teacher assistant made \$22,230.

Training, Other Qualifications and Advancement

Minimum requirements for teacher assistant positions include a high school diploma and previous experience working with children. Positions with instructional responsibilities usually require more advanced training. The No Child Left Behind Act has strict educational and training requirements for those working in Title 1 schools – those with a large proportion of students from low-income households. In general, most employers prefer to hire applicants who have some formal college training. A valid driver's license may be required in some districts. Before hiring any individual, employers may perform a background check on the selected applicant.

A number of two-year and community colleges offer associate's degree programs that prepare individuals for teaching assistant positions. However, many still acquire necessary skills through on-the-job training. During this period of time, teacher assistants gain a thorough understanding of class materials and instructional methods. In addition, they become familiar with the organization and operation of the school.

Teacher assistants should enjoy working with children and be willing to follow directions. Fairness and patience are needed when handling classroom situations. Strong communication and computer skills are essential. Individuals who speak a second language, especially Spanish, are in great demand to communicate with the growing number of students and parents whose primary language is not English.

Advancement usually takes the form of additional responsibilities and increased pay. Opportunities grow with experience or additional education. Some school districts even provide tuition reimbursement so that teacher assistants can earn their bachelor's degree and pursue licensed teaching positions. In return, individuals are required to teach in that school district for a certain length of time.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of teacher assistants include childcare workers, day care providers, teachers, librarians, library technicians, and library assistants.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Federation of Teachers, 555 New Jersey Ave. NW, Washington, DC 20001. Internet: <http://www.aft.org>
- National Resource Center for Paraprofessionals, 6526 Old Main Hall, Utah State University, Logan, UT 84322-6526. Internet: <http://www.nrcpara.org>
- National Education Association, 1201 16th St. NW, Washington, DC 20036. Internet: <http://www.nea.org>
- National Council for Accreditation of Teacher Education, 2010 Massachusetts Ave. NW, Suite 500, Washington, DC 20036-1023. Internet: <http://www.ncate.org>
- National Board for Professional Teaching Standards, 26555 Evergreen Rd., Suite 400, Southfield, MI 48076. Internet: <http://www.nbpts.org>
- National Association for the Education of Young Children, 1509 16th St. NW, Washington, DC 20036. Internet: <http://www.naeyc.org>
- Recruiting New Teachers, Inc., 385 Concord Ave., Suite 103, Belmont, MA 02478. Internet: <http://www.rnt.org>; <http://www.recruitingteachers.org>
- U.S. Department of Education, 400 Maryland Ave., SW, Washington, DC, 20202. Internet: <http://www.ed.gov>

**Science, Research,
Engineering & Information
Technology**

Science, Research, Engineering & Information Technology Introduction

This section of the *Handbook* contains occupational information on careers in science, research, engineering and information technology. Occupations in this career cluster include computer programmers, systems analysts, engineers, engineering technicians and biological scientists.

Rapid gains in computer and data processing services have resulted in many of the fastest growing occupations being information-technology related. These include systems analysts, database administrators, computer support specialists and computer engineers. Computer-related occupations employ a large portion of this cluster and are expected to grow. Job prospects should be best for college graduates who are up to date with the latest technologies and have the requisite computer skills. While most of these jobs require a bachelor's degree, persons without a degree may be eligible for computer support specialist positions provided they have certifications and practical experience.

A wide range of career opportunities exists in the engineering field, including industrial, chemical, electrical, mechanical, biomedical, environmental and nuclear engineers and engineering technicians. Employers will rely on engineers to improve and update product designs and manufacturing processes as a result of competitive pressures and increased technology. Nearly all engineering positions require a bachelor's degree or higher, while most engineering technicians hold a 2-year associate's degree.

Biological and medical scientists highlight the science and research component of this section. Research occupations have seen faster-than-average growth in recent years as biotechnology companies respond to increased demand for new pharmaceuticals. New knowledge obtained from biological research will translate into the need for new workers to take this research to the next level.

Science, Research, Engineering & Information Technology Occupations

The occupations in green are either new to this edition or have had a name change since the last.

Biological & Medical Scientists

Environmental Engineers

Biomedical Engineers

Geoscientists & Hydrologists

Chemical Engineers

Industrial Engineers

Chemists

Inspectors & Compliance Officers

Civil Engineers

Materials Engineers

Computer Programmers

Computer Systems Specialists

Drafters

Economists & Market Research Analysts

Electrical & Electronics Engineers

Engineering, Natural Science & Computer
Managers

Engineering Technicians

Mechanical Engineers

Nuclear Engineers

Operations Research Analysts

Science Technicians

Statisticians

Surveying & Mapping Specialists

Auxiliary aids and services are available upon request to individuals with disabilities.
Equal Opportunity Employer/Program

Contact the Center for Workforce Information & Analysis for alternate formats at workforceinfo@state.pa.us,
(717) 787-6466 or toll-free at 1-877-493-3282.

Biological & Medical Scientists

SOC CODES: 19-1021, 19-1022, 19-1023, 19-1029, 19-1041 and 19-1042

Significant Points

- Most employers require a doctoral degree in biological science.
- Keen competition is expected for research positions and grant money.
- About 50 percent were employed in colleges and universities.

Nature of the Work

- Biological & medical scientists study living organisms and their relationship to the environment. Workers are usually classified by the organism they study or by the specific activity they perform.
 - Aquatic biologists*** study plants and animals that live in water. Marine biologists concentrate on salt-water organisms while limnologists work with fresh water organisms.
 - Biochemists*** research the chemical composition of living things.
 - Botanists*** study plants and their environment.
 - Ecologists*** investigate the relationship among organisms and their environments.
 - Medical microbiologists*** study the relationship between organisms and disease.
 - Medical scientists*** research normal biological systems to understand the causes of and discover treatments for health problems. Those with a medical degree can administer drugs to patients.
 - Microbiologists*** investigate the growth and characteristics of microscopic organisms.
 - Physiologists*** study life functions of plants and animals under normal and abnormal conditions.
 - Zoologists*** research the origin, behavior, diseases and life processes of animals.
- Many scientists work in research and development, exploring new areas, or expanding on specialized research. Others work as consultants to business organizations or the government.
- Within private industry, individuals often submit grant proposals to obtain funding for their projects.

Working Conditions

- Most biological & medical scientists work a standard 40-hour week. Although most work is performed in offices and laboratories, additional time may be spent in clinics and hospitals.
- Biological scientists may be required to participate in field trips that involve strenuous physical activity and primitive living conditions.
- Safety procedures must be followed to avoid contamination from dangerous organisms or toxic substances.
- Scientists who depend on grant money to support their research may be under pressure to meet deadlines and conform to rigid specifications.

Employment

- Biological & medical scientists held about 154,400 jobs in 2004 in the United States and approximately 8,090 jobs in Pennsylvania.
- Almost half were employed with educational institutions, namely colleges and universities. Another 20 percent worked for firms that provide professional research and management services. About 16 percent worked for pharmaceutical and medicine manufacturing companies.
- The following table includes the industries that employed the most biological & medical scientists in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Educational Services	4,030	49.8%
Professional Services	1,640	20.3%
Manufacturing	1,310	16.2%
Health Care	420	5.2%

Job Outlook

- Employment of biological & medical scientists in Pennsylvania is expected to grow from approximately 8,090 in 2004 to approximately 9,050 in 2014. Biological & medical scientists can expect about 96 openings due to growth and about 170 replacement openings for approximately 266 total annual openings.
- Employment growth will be stimulated by an increased use of biotechnology techniques, environmental preservation concerns and expanded research in health issues. However, keen competition is expected for research positions and grant money.
- Opportunities for bachelor's and master's degree holders should be better as the number of science-related jobs in sales, marketing and research increases.
- The employment levels of these scientists are not usually affected by economic conditions. However, budgetary constraints could influence the amount of money that is allocated to new or existing projects.

Earnings

- In Pennsylvania, biological & medical scientists averaged \$53,900 to \$72,300 annually in 2005. The entry-level earnings were between \$33,100 and \$47,000, while experienced adult & vocational education teachers were paid anywhere from \$61,400 to \$85,000.
- The following table includes the average annual, entry level, and experienced level wages in 2005 for biological & medical scientists in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Biochemists & Biophysicists	\$72,290	\$46,930	\$84,970
Microbiologists	N/A	N/A	N/A
Zoologists & Wildlife Biologists	N/A	N/A	N/A
Biological Scientists, All Other	\$63,830	\$40,740	\$75,380
Epidemiologists	\$66,830	\$38,300	\$81,090
Medical Scientists	\$65,680	\$33,110	\$81,970

- No Pennsylvania-specific information was available for microbiologists. However, the average salary nationwide for microbiologists in 2005 was \$63,360.
- No Pennsylvania-specific information was available for zoologists & wildlife biologists. However, the average salary nationwide for zoologists & wildlife biologists in 2005 was \$55,280.

Training, Other Qualifications and Advancement

A doctoral degree in biological science is required for most independent research projects. However, scientists with a master's degree may get jobs in applied research or product development. Individuals with a bachelor's degree may work as research assistants or take jobs as technicians, medical laboratory technologists or high school biology teachers. Bachelor degree holders usually work in non-research jobs such as inspection or sales. Others choose to enter medical, dental or veterinary schools.

Because much of the work they perform is research oriented, medical scientists must also obtain a doctoral degree in biological science. Individuals who interact medically with patients must have a medical degree. Therefore, it is particularly helpful for medical scientists to earn both a Ph.D. and a medical degree. In addition to their formal education, medical scientists usually spend several years in a post-doctoral position before they apply for permanent jobs. This provides valuable laboratory experience and often leads to a permanent position.

Most colleges and universities offer degree programs in biological science. Curriculums for advanced degree programs usually emphasize a sub-field such as microbiology or botany. Beyond classroom instruction, students also complete fieldwork, laboratory research and a thesis.

Biological & medical scientists must be able to work well independently or as part of a team. Strong oral and written communications skills are essential. Physical stamina is important for those scientists who perform field research. Individuals who aspire to management positions should also possess strong business skills and be familiar with regulatory issues.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of biological & medical scientists include animal breeders, horticulturists, entomologists, foresters, range managers, soil conservationists, medical doctors, dentists, and veterinarians.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- The American Institute of Biological Sciences, 1444 I St. NW, Suite 200, Washington, DC 20005. Internet: <http://www.aibs.org>
- The American Physiological Society, 9650 Rockville Pike, Bethesda, MD 20814-3991. Internet: <http://www.the-aps.org/>
- Biotechnology Industry Organization, 1225 Eye St. NW, Suite 400, Washington, DC 20005. Internet: <http://www.bio.org>
- Botanical Society of America, 1735 Neil Ave., Columbus, OH 43210-1293. Internet: <http://www.botany.org>
- American Society for Microbiology, 1752 N Street NW, Washington, DC 20036. Internet: <http://www.asm.org>
- American Association of Pharmaceutical Scientists, 2107 Wilson Blvd, Suite 700, Arlington, VA 22201-3042. Internet: <http://www.aaps.org>
- Federation of American Societies for Experimental Biology, 9650 Rockville Pike, Bethesda, MD 20814. Internet: <http://www.faseb.org>

Biomedical Engineers

SOC CODE: 17-2031

Significant Points

- A graduate degree is recommended for most entry-level positions.
- Employment opportunities may be affected by geographic area and economic conditions.
- About one-quarter worked in hospitals.

Nature of the Work

- *Biomedical engineers* develop devices and procedures that solve medical and health-related problems.
- Many do research to develop and evaluate systems and products for use in the fields of biology and health, such as artificial organs, prostheses, instrumentation, medical information systems, and health management and care delivery systems.
- Some specialties within biomedical engineering include biomaterials, biomechanics, medical imaging, rehabilitation engineering and orthopedic engineering.

Working Conditions

- Many biomedical engineers work a standard 40-hour week. At times, deadlines or design standards may result in extra pressure, longer hours and considerable stress.
- Most engineers work in office buildings, laboratories or industrial plants

Employment

- Biomedical engineers held about 9,700 jobs in 2004 in the United States and around 450 jobs in Pennsylvania.
- About 44 percent worked for firms that provide professional design and research services. Almost 25 percent worked in the health care sector, specifically in hospitals.
- The following table includes the industry groups that employed the most biomedical engineers in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Professional Services	200	44.0%
Health Care	110	24.9%
Manufacturing	90	19.1%
Self-Employed	30	5.6%

Job Outlook

- Employment of biomedical engineers in Pennsylvania is expected to grow from approximately 450 in 2004 to approximately 540 in 2014. Biomedical engineers can expect about 9 openings due to growth and about 8 replacement openings for approximately 17 total annual openings.
- The aging of the population and the focus on health issues will increase the demand for better medical devices and equipment designed by biomedical engineers.
- The rehabilitation and orthopedic engineering specialties are growing quickly, increasing the need for biomedical engineers.
- Because of the growing interest in this field, the number of degrees granted in biomedical engineering has increased greatly, leading to the potential for competition for jobs.

Earnings

Average annual earnings of biomedical engineers in Pennsylvania were \$73,550 in 2005. The entry-level wage in 2005 was \$46,590 while an experienced biomedical engineer made \$87,030.

Training, Other Qualifications and Advancement

A graduate degree is recommended or required for most entry-level biomedical engineering positions. Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities, and computers can also be beneficial.

Continuing education is essential for all biomedical engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of biomedical engineers include architects; engineering and natural sciences managers; computer and information systems managers; mathematicians; drafters; engineering technicians; sales engineers; science technicians; agricultural and food scientists; biological scientists; conservation scientists and foresters; atmospheric scientists; chemists and materials scientists; environmental scientists; geoscientists; physicists; and astronomers.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Biomedical Engineering Society, 8401 Corporate Dr., Suite 225, Landover, MD 20785-2224. Internet: <http://www.bmes.org>

Chemical Engineers

SOC CODE: 17-2041

Significant Points

- Qualified applicants can expect keen competition for the limited number of job openings.
- A bachelor's degree is required for most entry-level positions.

Nature of the Work

- *Chemical engineers* design equipment, develop processes and test manufacturing methods. They may also supervise production.
- Although their knowledge cuts across many fields, most chemical engineers specialize in a particular chemical operation or function.
- Computer technology is increasingly used to optimize all phases of research and production.

Working Conditions

- Many chemical engineers work a standard 40-hour week. Deadlines or design standards may result in extra pressure, longer hours and considerable stress.
- Work is usually performed in office buildings, laboratories or industrial plants.
- Some travel to visit plants or work sites may be required.

Employment

- Chemical engineers held about 30,600 jobs in 2004 in the United States and approximately 1,430 jobs in Pennsylvania.
- About 72 percent worked for manufacturing companies, primarily those that produce pharmaceuticals and industrial chemicals. Others were employed with engineering and consulting firms that design chemical plants.
- The following table includes the industries that employed the most chemical engineers in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Basic Chemical Manufacturing	520	36.1%
Pharmaceutical & Medicine Manufacturing	150	10.2%
Scientific Research & Development Services	130	9.0%
Architectural & Engineering Services	120	8.5%

Job Outlook

- Employment of chemical engineers in Pennsylvania is expected to grow from approximately 1,430 in 2004 to approximately 1,440 in 2014. Chemical engineers can expect about 1 opening due to growth and about 43 replacement openings for approximately 44 total annual openings.
- Employment growth will be strongest in non-manufacturing industries. However, some opportunities will still exist in the manufacturing industry.
- Keen competition is expected as the number of qualified applicants outpaces the number of job openings.

Earnings

Average annual earnings of chemical engineers in Pennsylvania were \$73,520 in 2005. The entry-level wage in 2005 was \$52,720 while an experienced chemical engineer made \$83,930.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level chemical engineer jobs, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health, or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an

accredited engineering program, four years of work experience, and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical, and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities, and computers can also be beneficial.

Continuing education is essential for all chemical engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists, or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of chemical engineers include engineering managers, natural science managers, computer and information systems managers, engineering and science technicians, physical and life scientists, mathematicians, computer systems analysts, computer engineers, computer scientists, and architects.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Institute of Chemical Engineers, 3 Park Ave., New York, NY 10016-5991. Internet: <http://www.aiche.org>
- American Chemical Society, 1155 16th St. NW, Washington, DC 20036. Internet: <http://www.acs.org>

Chemists

SOC CODE: 19-2031

Significant Points

- Most entry-level positions require a bachelor's degree.
- Employment opportunities will be best in manufacturing companies and consulting firms.

Nature of the Work

- Chemists research chemicals and utilize their knowledge to develop new processes. Most specialize in a particular sub-field.
 - Analytical chemists* determine the structure, composition, and nature of substances.
 - Organic chemists* study the chemistry of carbon compounds, which make up all living things.
 - Inorganic chemists* research compounds that consist mainly of elements other than carbon.
 - Physical chemists* study the physical characteristics of atoms and molecules. They also investigate how chemical reactions work.
- Within research and development, chemists may work in basic or applied research. Basic research chemists investigate existing matter and the laws that govern the combination of elements, while applied research chemists create new products or improve existing ones.
- Computers and laboratory equipment are used to perform experiments and analyze data.

Working Conditions

- Most chemists work a standard 40-hour week.
- Although work is often performed in laboratories or offices, some must be done in chemical plants or outdoors.
- Proper safety procedures must be followed to reduce the risk of exposure when handling certain chemicals.

Employment

- Chemists held about 82,100 jobs in 2004 in the United States and approximately 4,100 jobs in Pennsylvania.
- Over 45 percent were employed in various manufacturing firms, particularly those that produce pharmaceuticals. Others worked for research and engineering consulting companies.
- The following table includes the industries that employed the most chemists in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Scientific Research & Development Services	960	23.4%
Architectural & Engineering Services	690	16.9%
Pharmaceutical & Medicine Manufacturing	660	16.2%

Job Outlook

- Employment of chemists in Pennsylvania is expected to grow from approximately 4,100 in 2004 to approximately 4,130 in 2014. Chemists can expect about three openings due to growth and about 134 replacement openings for approximately 137 total annual openings.
- An aging population and strong industry competition will create employment growth within manufacturing companies. This growth may be offset as companies continue to downsize and use outside contractors.
- Out-sourcing of research needs will create additional opportunities in research, development and testing firms.
- During periods of economic recession, chemists may be vulnerable to layoffs.

Earnings

Average annual earnings of chemists in Pennsylvania were \$62,090 in 2005. The entry-level wage in 2005 was \$37,310 while an experienced chemist made \$74,480.

Training, Other Qualifications and Advancement

The minimum educational requirement for entry-level chemist positions is usually a bachelor's degree in chemistry or a related discipline. In general, entry-level chemists work in quality control or analytical testing. Some assist senior chemists in their research.

Many colleges and universities offer accredited programs in chemistry. Although graduate students typically specialize in a particular sub-field, most undergraduate students do not. In fact, broadly trained undergraduates have more flexibility when job hunting or changing jobs. Employers will generally provide any additional training or education that is needed. Individuals interested in advancing to lead research chemist or administrative positions may need to obtain a doctoral degree in chemistry.

Aspiring chemists should be detail-oriented people who like working with their hands. Perseverance and curiosity are also important traits. Chemists should be able to work well independently or as part of a team. Background knowledge in science and mathematics is beneficial. In addition, most employers prefer to hire applicants who are able to apply computer skills to modeling techniques, simulation tasks and laboratory equipment operation. Anyone interested in the environmental field should also take additional courses in environmental studies and become familiar with current legislation.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of chemists include chemical engineers, agricultural scientists, biological scientists, chemical technicians, science technicians, materials engineers, physicists, and medical scientists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Chemical Society, 1155 16th St. NW, Washington, DC 20036. Internet: <http://www.acs.org>

Civil Engineers

SOC CODE: 17-2051

Significant Points

- A bachelor's degree is required for most entry-level positions.
- Employment opportunities may be affected by geographic area and economic conditions.

Nature of the Work

- *Civil engineers* design and supervise the construction of roads, buildings, airports, tunnels, dams and bridges.
- Major specialties include structural, environmental, construction, transportation and geo-technical engineering.
- Many civil engineers hold supervisory and administrative positions. Others work in design, construction, research or education.

Working Conditions

- Many civil engineers work a standard 40-hour week. At times, deadlines or design standards may result in extra pressure, longer hours and considerable stress.
- Work usually occurs near major industrial and commercial centers. However, some projects are located in remote areas or foreign countries.
- Some civil engineers move from place to place to work on different projects.

Employment

- Civil engineers held about 237,300 jobs in 2004 in the United States and around 7,260 jobs in Pennsylvania.
- About 58 percent were employed with companies that provide engineering consulting services. Another 23 percent worked for Federal, State and local government agencies.

Job Outlook

- Employment of civil engineers in Pennsylvania is expected to grow from approximately 7,260 in 2004 to approximately 7,410 in 2014. Civil engineers can expect about 15 openings due to growth and about 116 replacement openings for approximately 131 total annual openings.
- Population growth and an expanding economy will increase the demand for civil engineers. However, prospects will vary by geographic area.
- Civil engineers who are employed in construction and related industries may experience decreased employment opportunities during periods of economic downturn.

Earnings

Average annual earnings of civil engineers in Pennsylvania were \$64,330 in 2005. The entry-level wage in 2005 was \$45,780 while an experienced civil engineer made \$73,600.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level civil engineer jobs, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience, and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities and computers can also be beneficial.

Continuing education is essential for all civil engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of civil engineers include engineering managers, natural science managers, computer and information systems managers, engineering and science technicians, physical and life scientists, mathematicians, computer systems analysts, computer engineers, computer scientists, and architects.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Society of Civil Engineers, 1801 Alexander Bell Dr., Reston, VA 20191-4400.
Internet: <http://www.asce.org>

Computer Programmers

SOC CODE: 15-1021

Significant Points

- A growing number are employed on a temporary or contract basis.
- Job prospects will be best for college graduates who are up-to-date with the latest skills.
- About 1 in 4 worked for computer consulting firms.

Nature of the Work

- Computer programmers write, test and maintain the detailed instructions that computers must follow to perform their functions.
- Programmers write specific programs and then code them in a conventional programming language, an artificial intelligence language, or one of the most advanced function-oriented, or object-oriented languages. Since many languages are similar, programmers usually know more than one programming language and can often learn new languages easily.
- Programmers are often classified into two broad types: applications and systems.
 - *Applications programmers* focus on business, engineering or science. They write software to handle a specific job within an organization. They may also revise existing packaged software.
 - *Systems programmers* maintain and control computer systems software, such as operating systems, networked systems and database systems. These workers often assist applications programmers.
- Several programmers work together as a team under a senior programmer's supervision.
- The distinction between programmer and user has been blurred with the growing use of packaged software, like spreadsheets and databases.

Working Conditions

- Computer programmers often work long hours or weekends, usually in comfortable offices, to meet deadlines or fix critical problems that occur during off-hours.
- Telecommuting is common for computer professionals. As networks expand, more work can be done from remote locations.
- Computer-related workers are susceptible to eyestrain, back discomfort and wrist problems.

Employment

- Computer programmers held about 455,300 jobs in 2004 in the United States and approximately 21,310 jobs in Pennsylvania.
- Over 54 percent worked for service-providing companies, such as computer systems design firms. Others worked for colleges, data processing firms, insurance companies and software publishers.
- The following table includes the industry groups that employed the most computer programmers in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Services	11,590	54.4%
Wholesale & Retail Trade	2,390	11.2%
Finance & Insurance	2,300	10.8%
Information	2,210	10.4%
Manufacturing	1,260	5.9%

Job Outlook

- Employment of computer programmers in Pennsylvania is expected to grow from approximately 21,310 in 2004 to approximately 21,410 in 2014. Computer programmers can expect about 10 openings due to growth and about 503 replacement openings for approximately 513 total annual openings.

- As organizations attempt to control costs and keep up with changing technology, they will continue to need computer programmers to assist in conversions to new computer languages and systems.
- Despite numerous openings, only slight employment growth is expected. The consolidation of systems and applications and developments in packaged software will mean that many programmers will need to be retrained. Computer programmers will face increasing competition from programming businesses overseas where much routine work can be outsourced at a lower cost.
- As programming tasks become increasingly sophisticated, those with less than a bachelor's degree will face strong competition for jobs. Prospects should be best for college graduates with experience working with a variety of programming languages and tools.

Earnings

Average annual earnings of computer programmers were \$61,290 in 2005. The entry-level wage in 2005 was \$39,330 while an experienced computer programmer made \$72,280.

Training, Other Qualifications and Advancement

There are many training paths available for computer programmers. As the number of qualified applicants grows and the complexity of programming tasks increases, so does the level of education and experience employers require. Bachelor's degrees are commonly required although some computer programmers may qualify for certain jobs with a two-year degree or certificate. Even with a degree, employers are placing more emphasis on previous experience. Students can improve their employment prospects by participating in a college work-study program or by undertaking an internship.

Required knowledge will vary from job to job. Employers using computers for scientific or engineering applications usually prefer college graduates with a degree in computer or information science, mathematics, engineering or the physical sciences. Meanwhile, those employers using computers for business applications prefer to hire people who have had college courses in information systems and business. Although knowledge of traditional languages is still important, increasing emphasis is placed on newer, object-oriented programming languages and tools. Additionally, employers are seeking persons familiar with languages that involve graphic user interface (GUI) and systems programming. Technical or professional certification is a way to demonstrate a level of competency or quality and may provide a job seeker a competitive advantage.

When hiring computer programmers, employers look for people who think logically and pay close attention to detail. Computer programmers must be patient and persistent, especially under pressure. Ingenuity and imagination are particularly important when programmers design solutions and test their work for potential failures. Programmers must be able to communicate effectively with non-technical personnel.

Junior programmers may work alone on simple assignments after some initial instruction or on a team with more experienced programmers. Either way, beginning programmers usually work under close supervision. Skilled programmers who keep up to date with the latest technology may be promoted to lead programmer or supervisor positions. With general business experience, they may become programmer or systems analysts. Opportunities for work as consultants should arise for experienced programmers with expertise in a specific area.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of computer programmers include computer scientists, computer engineers, systems analysts, database administrators, statisticians, mathematicians, engineers, financial analysts, accountants, auditors, actuaries, and operations research analysts.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Association for Computing Machinery, 1515 Broadway, New York, NY 10036. Internet: <http://www.acm.org>
- Institute for Certification of Computing Professionals (ICCP), 2350 East Devon Ave., Suite 115, Des Plaines, IL 60018-4610. Internet: <http://www.iccp.org>
- Institute of Electrical and Electronics Engineers Computer Society, Headquarters Office, 1730 Massachusetts Ave. NW, Washington, DC 20036-1992. Internet: <http://www.computer.org>
- National Workforce Center for Emerging Technologies, 3000 Landerholm Circle SE N258, Bellevue, WA 98007-6484. Internet: <http://www.nwcet.org>

Computer Systems Specialists

SOC CODES: 15-1011, 15-1031, 15-1032, 15-1041, 15-1051, 15-1061, 15-1071, 15-1081, 15-1099 and 17-2061

Significant Points

- Relevant work experience and a bachelor's degree are required for many computer jobs.
- Expanding computer applications will create faster than average growth.

Nature of the Work

- Job tasks and occupational titles used to describe computer-related workers evolve rapidly, reflecting new areas of specialization or changes in technology.
- Systems analysts design new computer systems or update existing ones. They are also responsible for networking an organization's computers. *Network systems and data communications analysts* evaluate systems such as Local Area Networks (LAN), Wide Area Networks (WAN), Internet and Intranet systems.
- Computer engineers apply the theories and principles of science and mathematics to design hardware, software, networks and processes and to solve technical problems.

Hardware engineers design, develop, test, and supervise the manufacture of computer hardware.

Software engineers develop and test operating system software or applications software.

- Computer scientists design computers and the software that runs them. They also develop information technologies and adapt principles for applying computers to new uses.

Database administrators determine ways to organize and store data. They set up computer databases, test and coordinate changes to them and address security measures.

Computer support specialists provide technical support for hardware, software and system problems. This group includes technical support specialists, help-desk technicians and customer service representatives.

Network or computer systems administrators maintain, analyze and monitor network hardware and software. Administrators may also plan, coordinate and implement network security measures.

- Growth of the Internet has generated a variety of occupations relating to design, development and maintenance of websites and their servers.

Webmasters are responsible for all technical aspects of a website.

Web developers, also called *web designers*, are responsible for day-to-day site design and creation.

Working Conditions

- Computer systems specialists work about 40 hours per week, usually in offices or laboratories. Evening or weekend work may be necessary to meet deadlines or solve specific problems.
- As telecommuting networks expand, more work can be done from remote locations.
- Computer-related workers are susceptible to eyestrain, back discomfort and hand and wrist problems.

Employment

- Computer systems specialists held about 2.5 million jobs in 2004 in the United States and approximately 86,210 jobs in Pennsylvania.
- Although computer personnel are increasingly employed in every sector of the economy, over 52 percent were employed with service-providing firms, such as computer system design and consulting companies. Others worked for colleges and universities, insurance carriers or government agencies.
- The following table includes the industry groups that employed the most computer systems specialists in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Services	45,470	52.7%
Information	9,290	10.8%
Finance & Insurance	9,270	10.8%
Manufacturing	7,080	8.2%
Wholesale & Retail Trade	5,450	6.3%

Job Outlook

- Employment of computer systems specialists in Pennsylvania is expected to grow from approximately 86,210 in 2004 to approximately 108,770 in 2014. These workers can expect about 2,256 openings due to growth and about 974 replacement openings for approximately 3,230 total annual openings.
- Advanced technology has created demand for computer support specialists and help-desk personnel. Likewise, the explosive growth in electronic commerce is fueling the demand for database administrators.
- As technology becomes more sophisticated and complex, employers demand a higher level of skill and expertise. Prospects should be best for individuals with a college degree.

Earnings

- In Pennsylvania, computer systems specialists averaged \$40,500 to \$82,400 annually in 2005. The entry-level earnings were between \$25,900 and \$58,300, while experienced computer systems specialists were paid anywhere from \$47,800 to \$113,800.
- The following table includes the average annual, entry level, and experienced level wages in 2005 for computer systems specialists in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Computer & Information Scientists, Research	\$94,310	\$55,490	\$113,720
Computer Software Engineers, Applications	\$77,030	\$52,200	\$89,440
Computer Software Engineers, Systems Software	\$79,610	\$54,460	\$92,190
Computer Support Specialists	\$40,550	\$25,910	\$47,880
Computer Systems Analysts	\$66,360	\$44,800	\$77,140
Database Administrators	\$60,210	\$36,950	\$71,840
Network & Computer Systems Administrators	\$62,050	\$41,090	\$72,520
Network Systems & Data Communications Analysts	\$65,490	\$40,730	\$77,860
Computer Specialists, Other	\$53,420	\$31,060	\$64,600
Computer Hardware Engineers	\$82,380	\$58,250	\$94,440

Training, Other Qualifications and Advancement

There is no universally accepted way to prepare for a job as a computer systems specialist. However, most employers place a premium on college education and relevant work experience. Most jobs require an associate's or bachelor's degree. For more complex jobs, a graduate degree is often required. A Ph.D. in computer science or engineering may be required for jobs in research laboratories or academic institutions.

Computer hardware engineers often have a computer or electrical engineering degree. Software engineers are more likely to hold a degree in computer science or software engineering. Systems analysts, programmer analysts and database administrators should have a degree in computer science, information science or management information systems (MIS). Community colleges, technical institutes and proprietary schools offer an associate's degree in computer science. These programs are geared toward the needs of local businesses and are often occupation specific. Graduates usually become computer support specialists.

Technical or professional certification is a way to demonstrate a level of competency in a particular field. Product vendors or software firms offer certification and may require professionals who work with their products to be certified. In fact, professional certification may provide a job seeker with a competitive advantage.

Despite a preference towards technical degrees, many individuals find employment in computer-related occupations. Employers usually look for people who have a broad knowledge base, strong problem solving skills and good interpersonal skills. Strong communications skills and the ability to work independently or as part of a team are also important traits. Art or graphic design skills may be desirable for webmasters or web developers.

Technological advances come so rapidly in the computer field that continuous study is necessary to keep skills up to date. Employers, vendors and formal training institutions offer continuing education. Additional training may come from seminars offered by professional computing societies.

Computer engineers and scientists may advance into managerial or project leadership positions. Systems analysts may be promoted to senior or lead systems analysts. Computer professionals with considerable expertise in a particular area may find lucrative opportunities as independent consultants.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of computer systems specialists include computer programmers, financial analysts, urban planners, engineers, mathematicians, statisticians, operations research analysts, management analysts, and actuaries.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Association for Computing Machinery, 1515 Broadway, New York, NY 10036. Internet: <http://www.acm.org>
- Institute for Certification of Computing Professionals (ICCP), 2350 East Devon Ave., Suite 115, Des Plaines, IL 60018-4610. Internet: <http://www.iccp.org>
- Institute of Electrical and Electronics Engineers Computer Society, Headquarters Office, 1730 Massachusetts Ave. NW, Washington, DC 20036-1992. Internet: <http://www.computer.org>
- National Workforce Center for Emerging Technologies, 3000 Landerholm Circle SE, Bellevue, WA 98007. Internet: <http://www.nwcet.org>

Drafters

SOC CODES: 17-3011, 17-3012 and 17-3013

Significant Points

- Opportunities should be best for those with formal training and experience using CAD systems.
- Employers are most interested in applicants who have completed postsecondary school training.
- Voluntary certification is available.

Nature of the Work

- Drafters prepare technical drawings that are used by production and construction workers to build everything from manufactured products to structures. Their drawings specify dimensions, materials to be used, and which procedures to follow.
- Most drafters now use computer-aided drafting (CAD) systems to prepare drawings. This tool allows drawings to be stored electronically so that revisions or duplications can be made easily. However, manual drafting may still be used for certain applications.
- As CAD technology advances and the cost continues to fall, it is likely that almost all drafters will use CAD systems on a regular basis in the future.
- Drafting work has many specializations and titles may denote a particular discipline.

Architectural drafters draw structural features of buildings and other structures. They may specialize by the type of structure or material used.

Aeronautical drafters prepare engineering drawings used in the manufacture of aircraft, missiles, and parts.

Electrical drafters prepare wiring and layout diagrams used by workers who erect, install, and repair electrical equipment and wiring.

Electronic drafters draw wiring diagrams, circuit board assembly diagrams, schematics, and layout drawings used in the manufacture, installation, and repair of electronic devices and components.

Civil drafters prepare drawings and maps used in major construction or civil engineering projects.

Mechanical drafters prepare detail and assembly drawings of machinery and mechanical devices.

Process piping or pipeline drafters prepare drawings used for layout, construction, and operation of oil and gas fields, refineries, chemical plants, and process piping systems.

Working Conditions

- Drafters usually work in comfortable offices furnished to accommodate their tasks. They may sit at adjustable drawing boards or drafting tables when doing manual drawings.
- Because they spend most of their time working on computers, drafters are susceptible to eyestrain, back discomfort, and hand and wrist problems.

Employment

- Drafters held about 230,000 jobs in 2004 in the United States and approximately 11,160 jobs in Pennsylvania.
- Almost 45 percent worked in engineering service firms that do drafting work on a contract basis. Others were employed in manufacturing industries.

Job Outlook

- Employment of drafters in Pennsylvania is expected to decrease from approximately 11,160 in 2004 to approximately 10,370 in 2014. About 314 annual openings will result from replacement needs. Although no net employment growth is expected statewide, growth openings may occur in some areas.
- Although industrial growth and increasingly complex design problems will increase the demand for drafting services, the increased use of CAD systems should offset this growth.
- Opportunities should be best for individuals who have at least two years of postsecondary training and considerable experience using CAD systems.

Earnings

- In Pennsylvania, drafters averaged \$39,700 to \$45,600 annually in 2005. Entry-level drafters earned between \$27,700 and \$29,800, while experienced drafters earned anywhere from \$45,700 to \$53,900.
- The following table includes the average annual, entry level, and experienced level wages in 2005 for different drafters in Pennsylvania.

Occupational Title	Average Hourly Wage	Entry Level Wage	Experienced Level Wage
Architectural & Civil Drafters	\$39,740	\$27,750	\$45,730
Electrical & Electronics Drafters	\$45,540	\$28,990	\$53,810
Mechanical Drafters	\$45,240	\$29,720	\$53,000

Training, Other Qualifications and Advancement

Employers are most interested in applicants who have completed postsecondary training in drafting and acquired a solid background in computer-aided drafting and design (CADD) techniques.

Individuals planning a career in drafting should take courses in computer technology, math, science, design, and computer graphics. Mechanical and visual aptitude is important. Aspiring drafters should be able to draw freehand and do detailed work accurately and neatly. In addition, they should have good interpersonal, communication, and problem-solving skills.

Many public and private schools provide training programs in drafting. However, prospective students should be careful in selecting a program, as the kind and quality varies considerably. Technical training obtained in the Armed Forces is highly rated, although some additional training may be required for civilian drafting jobs.

Entry-level or junior drafters perform routine work under close supervision. After gaining experience, junior drafters progress to more difficult work with less supervision. They may be required to exercise more judgment and perform calculations when preparing and modifying drawings. Many employers will pay for continuing education courses for their experienced drafters.

The American Design Drafting Association (ADDA) has established a voluntary certification program for drafters. Although most employers do not require certification, it demonstrates that nationally recognized standards have been met. Individuals who wish to become certified must pass the Drafter Certification Test, which evaluates knowledge and understanding of basic drafting concepts.

Experienced drafters may advance to senior drafter, designer or supervisory positions. With appropriate education, some workers become engineering technicians, engineers or architects. A few drafters go into business for themselves.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of drafters include architects, landscape architects, designers, engineers, engineering technicians, surveyors, cartographers, and science technicians.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Accrediting Commission of Career Schools and Colleges of Technology, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: <http://www.accsct.org>
- American Design Drafting Association, 105 E. Main St., Newbern, TN 38059. Internet: <http://www.adda.org>

Economists & Market Research Analysts

SOC CODES: 19-3011, 19-3021 and 19-3022

Significant Points

- Graduate-level training is generally required for entry-level positions.
- Opportunities will be best in private industry.

Nature of the Work

- **Economists** study how society distributes scarce resources such as land, labor, raw materials and machinery to produce goods and services. They conduct research, analyze data, monitor economic trends and develop forecasts. Many are concerned with practical applications of economic policy.
- **Market research analysts** are concerned with the potential sales of a product or service. They analyze past history to predict future sales. Some analysts gather data on competitor's prices and distribution methods.

Working Conditions

- Economists & market research analysts have structured work schedules, which may be interrupted by special requests for data. Deadlines and tight schedules create pressure and a need for overtime.
- Travel may be required to attend meetings and conferences.
- Although most research is performed individually, some projects do require analysts to work as part of a team.

Employment

- Economists & market research analysts held about 224,900 jobs in 2004 in the United States and approximately 5,000 jobs in Pennsylvania.
- Over 28 percent were employed with professional consulting firms. Others worked for insurance carriers.
- The following table includes the industry groups that employed the most economists & market research analysts in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Professional Services	1,440	28.7%
Finance & Insurance	740	14.9%
Management of Companies	610	12.3%
Manufacturing	520	10.3%
Information	320	6.5%

Job Outlook

- Employment of economists & market research analysts in Pennsylvania is expected to grow from approximately 5,000 in 2004 to approximately 5,770 in 2014. These workers can expect about 77 openings due to growth and about 131 replacement openings for approximately 208 total annual openings.
- The growing need for economic analysis should result in additional job openings. Opportunities will be best in private industry as many companies contract out their research services.
- Graduates with a bachelor's degree will find a limited number of positions.

Earnings

- In Pennsylvania, economists & market research analysts averaged \$29,000 to \$81,300 annually in 2005. The entry-level earnings were between \$16,600 and \$50,100, while experienced analysts were paid anywhere from \$35,100 to \$96,900.
- The following table includes the average annual, entry level, and experienced level wages in 2005 for economists & market research analysts in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Economists	\$81,230	\$50,020	\$96,840
Market Research Analysts	\$60,070	\$28,920	\$75,650
Survey Researchers	\$29,020	\$16,690	\$35,190

Training, Other Qualifications and Advancement

Graduate-level training is required for most economist and market research analyst jobs. However, applicants with a bachelor's degree in economics or marketing often obtain entry-level positions as research assistants, management trainees, marketing interviewers, or sales representatives. Within the education industry, instructors at junior and community colleges must have a master's degree. A doctoral degree is required for positions at most colleges and universities.

Aspiring economists and market research analysts must be detail-oriented individuals. Independent research projects also require patience and persistence. Strong oral and written communication skills are essential. Courses in business, marketing, consumer behavior, social science, mathematics, and statistics are beneficial.

In time, experienced economists and market research analysts are assigned their own research projects. In order to be promoted to a top-level position, candidates may have to obtain a doctoral degree.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of economists & market research analysts include financial managers, financial planners, insurance underwriters, actuaries, credit analysts, loan officers, budget analysts, accountants, auditors, statisticians, psychologists, and sociologists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- National Association for Business Economics, 1233 20th St. NW, Suite 505, Washington, DC 20036. Internet: <http://www.nabe.com>
- Marketing Research Association, 1344 Silas Deane Hwy, Suite 306, Rocky Hill, CT 06067-1342. Internet: <http://www.mra-net.org>
- Council of American Survey Research Organizations, 170 N. Country Road, Suite 4, Port Jefferson, NY 11777. Internet: <http://www.casro.org/>

Electrical & Electronics Engineers

SOC CODES: 17-2071 and 17-2072

Significant Points

- A bachelor's degree is required for most entry-level positions.
- Continuing education is critical in order for engineers to keep abreast of the latest technologies.

Nature of the Work

- *Electrical & electronics engineers* design, develop, test and supervise the production of electrical and electronic equipment.
- Most engineers specialize in a particular area, such as power generation, communications, computer electronics or equipment manufacturing.

Working Conditions

- Many electrical & electronics engineers work a standard 40-hour week. Deadlines or design standards may result in extra pressure, longer hours and considerable stress.
- Work is usually performed in office buildings, laboratories, or industrial plants.
- Some travel may be required to visit plants or work sites.

Employment

- Electrical & electronics engineers held about 298,800 jobs in 2004 in the United States and approximately 9,000 jobs in Pennsylvania.
- Over 32 percent were employed with manufacturing companies, primarily those that make electronic instruments. About 30 percent worked for engineering and management consulting firms.
- The following table includes the industry groups that employed the most electrical & electronics engineers in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Manufacturing	2,940	32.7%
Professional Services	2,650	29.4%
Management of Companies	740	8.3%
Information	690	7.6%

Job Outlook

- Employment of electrical & electronics engineers in Pennsylvania is expected to grow from approximately 9,000 in 2004 to approximately 9,560 in 2014. Electrical & electronics engineers can expect about 56 openings due to growth and about 177 replacement openings for approximately 233 total annual openings.
- Opportunities should be favorable since the number of job openings is expected to be roughly in balance with the supply of college graduates.
- Electrical & electronics engineers who fail to keep up with changes in technology risk layoffs and are more likely to be passed over for advancement.

Earnings

- Average annual earnings of electrical engineers in Pennsylvania were \$71,490 in 2005. The entry-level wage in 2005 was \$47,900 while an experienced electrical engineer made \$83,290.
- Average annual earnings of electronics engineers in Pennsylvania were \$82,870 in 2005. The entry-level wage in 2005 was \$55,060 while an experienced electronics engineer made \$96,780.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level engineering positions, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in

engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities and computers can also be beneficial.

Continuing education is essential for all electrical & electronics engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of electrical & electronics engineers include engineering managers, natural science managers, computer & information systems managers, engineering & science technicians, physical & life scientists, mathematicians, computer systems analysts, computer engineers, computer scientists, and architects.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Institute of Electrical and Electronics Engineers – USA, 1828 L St. NW, Suite 1202, Washington, DC 20036-5104. Internet: <http://www.ieee.org>

Engineering, Natural Science & Computer Managers

SOC CODES: 11-3021, 11-9041 and 11-9121

Significant Points

- A master's degree is required for most managerial positions.
- Job opportunities are closely related to the employment growth of the workers they supervise.
- Administrative and communication skills are just as important as technical knowledge.

Nature of the Work

- Engineering, natural science & computer managers are responsible for the planning and coordinating of research, design, production and computer-related activities within an organization. They may prepare detailed plans for the accomplishment of scientific and technical goals.

Engineering managers supervise individuals who design and develop products, systems and processes.

Natural science managers direct research and development projects. They may also coordinate activities such as testing, quality control and production.

Computer managers analyze the computer and information systems needs of their organization.

- For effective performance, managers must have knowledge of administrative procedures as well as technical skills. Administrative duties may include budgeting, purchasing equipment, hiring personnel and training staff.

Working Conditions

- Most engineering, natural science & computer managers work at least 40 hours per week. Longer hours may be required to meet project deadlines.
- Work may be performed in an office, laboratory or industrial plant.
- Short timeframes and tight budgets may cause considerable pressure for managers.

Employment

- Engineering, natural science & computer managers held about 512,900 jobs in 2004 in the United States and approximately 22,440 jobs in Pennsylvania.
- About 44 percent worked for service-providing establishments, such as architectural and engineering consulting firms. Another 25 percent were employed with manufacturing companies.
- The following table includes the industries that employed the most engineering, natural science & computer managers in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Services	9,910	44.2%
Manufacturing	5,620	25.0%
Government	1,960	8.7%
Finance & Insurance	1,540	6.9%
Trade	1,370	6.1%

Job Outlook

- Employment of engineering, natural science & computer managers in Pennsylvania is expected to grow from approximately 22,440 in 2004 to approximately 25,390 in 2014. These managers can expect about 295 openings due to growth and about 422 replacement openings for approximately 717 total annual openings.
- Employment growth for engineering, natural science & computer managers is closely related to the growth of the workers they supervise. Technological advancements will stimulate the need for workers in many engineering, science and computer-related occupations.
- Opportunities will be best for applicants with advanced technical knowledge and strong administrative skills.

Earnings

- In Pennsylvania, engineering, natural science & computer managers averaged \$98,400 to \$110,600 annually in 2005. The entry-level earnings were between \$58,700 and \$72,400, while experienced managers were paid anywhere from \$118,200 to \$129,800.
- Managers often receive additional benefits, such as expense accounts, stock options and monetary bonuses.
- The following table includes the average annual, entry level, and experienced level wages in 2005 for engineering, natural science & computer managers in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Computer & Information Systems Managers	\$98,450	\$58,770	\$118,290
Engineering Managers	\$102,160	\$67,670	\$119,410
Natural Sciences Managers	\$110,590	\$72,350	\$129,710

Training, Other Qualifications and Advancement

Most engineering, natural science & computer manager positions require a master's degree and previous work experience. In some occupations, a bachelor's degree may be sufficient. Certain employers require science managers to obtain a doctoral degree.

Managers usually start their careers as engineers, scientists, systems analysts, computer engineers or computer programmers. When filling open managerial positions, employers look for qualified workers who possess administrative and communication skills in addition to their technical knowledge. To keep abreast of technological advancements and industry changes, managers must continuously update their knowledge through continuing education classes and seminars. In fact, many employers will pay for their managers to attend these classes.

Some engineering, natural science & computer managers may advance to higher positions within their discipline. Others become managers in non-technical areas such as marketing, human resources or sales.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of engineering, natural science & computer managers include engineers, life scientists, physical scientists, computer system specialists, mathematicians, general managers, and top executives.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Society for Engineering Management. 614 Pine St., Suite 206B, PO Box 820. Rolla, MO 65402-0820. Internet: www.asem.org

Engineering Technicians

SOC CODES: 17-3022, 17-3023, 17-3024, 17-3026 and 17-3027

Significant Points

- Employers prefer to hire applicants with an associate's degree in engineering technology.
- New specialties will create many additional job openings.
- Voluntary certification is available for qualified technicians.

Nature of the Work

- Engineering technicians use the principles and theories of science, engineering and mathematics to help solve technical problems in research and development, manufacturing, sales, construction and maintenance. Most technicians specialize in a certain area, working in the same disciplines as engineers and scientists.

Civil engineering technicians plan and build highways, buildings, bridges, dams and wastewater treatment systems. They may also perform land-surveying studies and inspections.

Electrical and electronics engineering technicians are responsible for designing, developing, testing and manufacturing electrical and electronic equipment.

Electro-mechanical technicians design, develop, test and manufacture electrical and computer controlled mechanical systems.

Industrial engineering technicians study the efficient use of personnel, materials and machines in businesses. They prepare layouts of equipment, make statistical studies and analyze production costs.

Mechanical engineering technicians help design, test and manufacture industrial machinery and mechanical parts. They may also estimate labor costs, equipment life and plant space.

- Most technicians work in research and development. Others perform quality control work such as inspecting products and conducting tests.

Working Conditions

- Most engineering technicians work a standard 40-hour week. Deadlines may result in longer hours, extra pressure and considerable stress.
- Work may be performed in offices, laboratories, industrial plants or at construction sites.
- Proper safety procedures must be followed at all times to help avoid common hazards from equipment, chemicals or toxic materials.

Employment

- Engineering technicians held about 410,900 jobs in 2004 in the United States and approximately 14,180 jobs in Pennsylvania.
- About 48 percent worked for manufacturing establishments. Another 27 percent were employed with service-providing companies, such as architectural and engineering firms.
- The following table includes the industry groups that employed the most engineering technicians in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Manufacturing	6,730	47.5%
Services	3,830	27.0%
Trade	1,350	9.5%
Government	910	6.4%

Job Outlook

- Employment of engineering technicians in Pennsylvania is expected to grow from approximately 14,180 in 2004 to approximately 14,870 in 2014. Engineering technicians can expect about 69 openings due to growth and about 296 replacement openings for approximately 365 total annual openings.

- Employment levels may be influenced by economic conditions although technological advancements will continue to increase worker productivity and limit growth. New specialties will create additional job openings.
- Most employers prefer to hire technicians who are skilled in new technology and require minimal training. As a result, opportunities will be best for individuals with an associate degree in engineering technology.

Earnings

- In Pennsylvania, engineering technicians averaged \$38,300 to \$45,800 annually in 2005. The entry-level earnings were between \$26,200 and \$31,500, while experienced engineering technicians were paid anywhere from \$44,400 to \$53,500.
- The following table includes the average annual, entry level, and experienced level wages in 2005 for engineering technicians in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Civil Engineering Technicians	\$38,390	\$26,220	\$44,480
Electrical & Electronic Engineering Technicians	\$45,760	\$30,700	\$53,290
Electro-Mechanical Technicians	\$42,700	\$31,440	\$48,340
Industrial Engineering Technicians	\$45,580	\$29,890	\$53,420
Mechanical Engineering Technicians	\$44,180	\$30,340	\$51,100

Training, Other Qualifications and Advancement

Formal training for engineering technicians is available through vocational-technical institutes, community colleges and the Armed Forces. Programs at vocational-technical schools offer extensive technical training but less theory and general education than community colleges. The civilian industry also has high regard for training obtained through the Armed Forces. However, the skills acquired in military programs are often narrowly focused and additional training may be required. Graduates of any accredited program are recognized to have achieved an acceptable level of competence in the technical courses required for this occupation.

Some colleges offer a pre-engineering program that focuses on academic work rather than hands-on applications. Students in these programs usually intend to enter a four-year engineering program upon graduation. Graduates who elect not to pursue an engineering degree are often hired to work as technologists or applied engineers, not as engineering technicians.

Most employers prefer to hire graduates with an associate's degree in engineering technology. Once hired, new technicians go through a period of on-the-job training where they learn how to perform routine tasks. In time, they are assigned to more difficult projects.

Although certification is not required, it may provide applicants with a competitive advantage for job openings. The National Institute for Certification in Engineering Technologies (NICET) has established a voluntary certification program for engineering technicians. Certification is available at various levels. Interested technicians must pass a written examination and have sufficient experience.

Aspiring technicians must be creative, able to work with others and have strong communication skills. A solid background in science and mathematics is essential. Some may even be promoted to supervisory positions.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of engineering technicians include science technicians, drafters, surveyors, broadcast technicians, sound technicians, and health technicians.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Junior Engineering Technical Society (JETS), 1420 King St., Suite 405, Alexandria, VA 22314. Internet: <http://www.jets.org>
- Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202. Internet: <http://www.abet.org>
- National Institute for Certification in Engineering Technologies (NICET), 1420 King St., Alexandria, VA 22314-2794. Internet: <http://www.nicet.org>

Environmental Engineers

SOC CODE: 17-2081

Significant Points

- A bachelor's degree is required for most entry-level positions.
- Employment opportunities may be affected by geographic area and economic conditions.

Nature of the Work

- *Environmental engineers* are involved in water and air pollution control, recycling, waste disposal and public health issues.
- Many environmental engineers work as consultants, helping their clients to comply with regulations and to clean up hazardous sites.
- Environmental engineers are concerned with local and worldwide environmental issues.

Working Conditions

- Many environmental engineers work a standard 40-hour week. At times, deadlines or design standards may result in extra pressure, longer hours, and considerable stress.
- Some environmental engineers move from place to place to work on different projects.

Employment

- Environmental engineers held about 49,300 jobs in 2004 in the United States and approximately 1,680 jobs in Pennsylvania.
- Over 36 percent were employed with architectural and engineering consulting firms. Others worked for management consulting companies, government agencies and research firms.
- The following table includes the industries that employed the most environmental engineers in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Architectural & Engineering Services	610	36.2%
Management & Technical Consulting Services	230	13.5%
Federal Government	210	12.5%
Scientific Research & Development Services	110	6.5%

Job Outlook

- Employment of environmental engineers in Pennsylvania is expected to grow from approximately 1,680 in 2004 to approximately 1,960 in 2014. Environmental engineers can expect about 28 openings due to growth and about 29 replacement openings for approximately 57 total annual openings.
- A shift in emphasis toward preventing problems rather than controlling those that already exist, as well as increasing public health concerns, also will spur demand for environmental engineers.
- However, political factors determine the job outlook for environmental engineers more than that for other engineers. Looser environmental regulations would reduce job opportunities; stricter regulations would enhance opportunities.

Earnings

Average annual earnings of environmental engineers in Pennsylvania were \$70,650 in 2005. The entry-level wage in 2005 was \$44,650 while an experienced environmental engineer made \$83,660.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level positions, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience, and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities and computers can also be beneficial.

Continuing education is essential for all environmental engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of environmental engineers include architects; engineering, natural sciences & computer managers; mathematicians; drafters; engineering technicians; sales engineers; science technicians; agricultural & food scientists; biological scientists; conservation scientists & foresters; atmospheric scientists; chemists & materials scientists; environmental scientists; geoscientists; physicists; and astronomers.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Academy of Environmental Engineers, 130 Holiday Court, Suite 100, Annapolis, MD 21401. Internet: <http://www.aaee.net>

Geoscientists & Hydrologists

SOC CODES: 19-2042 and 19-2043

Significant Points

- Opportunities will be best for individuals who can speak a foreign language and are willing to work abroad.
- A bachelor's degree is adequate for most entry-level positions.

Nature of the Work

- Geoscientists locate energy resources, preserve the environment, predict future geological hazards and offer advice on land use projects.

Geologists study the composition, processes and history of the Earth.

Geophysicists study the Earth's surface and its internal composition.

Oceanographers study the world's oceans and coastal waters.

- Numerous sub-disciplines or specialties exist under the three major disciplines. Specific job duties will depend on which area the geoscientist is working in.
- *Hydrologists* study the quantity, distribution, circulation and physical properties of underground and surface waters. The work they do is important in environmental preservation, remediation and flood control.

Working Conditions

- Many geoscientists divide their time among fieldwork, office work and laboratory work. Fieldwork requires long hours but employees are usually rewarded with longer vacations.
- Oceanographers spend considerable time at sea, working on academic research ships. Likewise, geologists may travel to remote areas in foreign countries to explore field sites.
- Geoscientists working in research positions or consulting jobs may be required to design programs and write grant proposals.

Employment

- Geoscientists & hydrologists held about 35,600 jobs in 2004 in the United States and approximately 830 jobs in Pennsylvania.
- About 34 percent were employed with architectural and engineering consulting firms. Others worked for government agencies and management companies.
- The following table includes the industries that employed the most geoscientists & hydrologists in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Architectural & Engineering Services	280	33.9%
Federal & State Government	230	27.8%
Management & Technical Consulting Services	210	25.1%

Job Outlook

- Employment of geoscientists & hydrologists in Pennsylvania is expected to grow from approximately 830 in 2004 to approximately 900 in 2014. Geoscientists & hydrologists can expect about 7 openings due to growth and about 15 replacement openings for approximately 22 total annual openings.
- Employment growth will be driven by the need for organizations to comply with an increasing number of environmental laws and regulations.
- Opportunities should be best for those who can speak a foreign language and are willing to work abroad.
- Budgetary constraints will affect the employment growth of individuals who rely on federal funding.

Earnings

- Average annual earnings of geoscientists in Pennsylvania were \$63,970 in 2005. The entry-level wage in 2005 was \$41,080 while an experienced geoscientist made \$75,420.

- Average annual earnings of hydrologists in Pennsylvania were \$75,620 in 2005. The entry-level wage in 2005 was \$60,320 while an experienced hydrologist made \$83,280.

Training, Other Qualifications and Advancement

Although a bachelor's degree is adequate for most entry-level positions, jobs with advancement potential usually require a master's degree. A doctoral degree is needed for many research positions. Graduates with physics, chemistry, mathematics or computer science degrees may qualify for some positions, if they also studied geology.

Several colleges and universities offer a bachelor's degree in geology but only a limited number offer programs in geophysics and oceanography. Traditional courses emphasizing classical methods and topics are important for all geoscientists and hydrologists. Students interested in working in the environmental or regulatory fields should also take courses in hydrology, hazardous waste management, environmental legislation, chemistry, fluid mechanics and geologic logging.

Computer skills are essential for aspiring geoscientists & hydrologists. Students who have experience with computer modeling, data analysis, digital mapping, remote sensing and geographic information systems (GIS) will be the most prepared to enter the job market. Knowledge of the Global Positioning System (GPS) is also very important. Internships may be beneficial because employers often seek applicants with previous field experience.

Aspiring geoscientists & hydrologists must be inquisitive and open-minded. The ability to think logically is very important. Strong interpersonal and communication skills are essential. Because many jobs require foreign travel, knowledge of a second language is advantageous. Geoscientists & hydrologists involved in fieldwork must also have physical stamina.

Most geoscientists & hydrologists begin their careers as research assistants or laboratory technicians. After gaining some experience, they are entrusted with more difficult assignments. Eventually, workers may be promoted to project leader or program manager.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of geoscientists & hydrologists include engineering technicians, science technicians, surveyors, life scientists, physicists, chemists, atmospheric scientists, mathematicians, computer scientists, soil scientists, and cartographers.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Geological Institute, 4220 King St., Alexandria, VA 22302-1502. Internet: <http://www.agiweb.org>
- Geological Society of America, PO Box 9140, Boulder, CO 80301-9140. Internet: <http://www.geosociety.org>
- American Association of Petroleum Geologists, PO Box 979, Tulsa, OK 74101-0979.
Internet: <http://www.aapg.org>
- American Geophysical Union, 2000 Florida Ave. NW, Washington, DC 20009-1277.
Internet: <http://www.agu.org>
- Society of Exploration Geophysicists, PO Box 702740, Tulsa, OK 74170-2740. Internet: <http://www.seg.org>
- The Marine Technology Society, 5565 Sterrett Pl., Suite 108, Columbia, MD 21044.
Internet: <http://www.mtsociety.org>

Industrial Engineers

SOC CODE: 17-2112

Significant Points

- Efforts to reduce costs and increase productivity will increase demand.
- A bachelor's degree is required for most entry-level positions.

Nature of the Work

- *Industrial engineers* determine the most effective ways for an organization to use people, machines, materials, information and energy to make a product or provide a service.
- To solve organizational and production problems most efficiently, industrial engineers study the product and its requirements. They use mathematical methods to meet those requirements and design improved systems.
- They develop systems that aid in financial planning, cost analysis, activity coordination, product quality and physical distribution.

Working Conditions

- Many industrial engineers work a standard 40-hour week. Pressing deadlines may result in longer work hours and considerable stress.
- Industrial engineers usually work out of office buildings or industrial plants.
- Extensive travel to industrial plant sites may be necessary.

Employment

- Industrial engineers held about 176,700 jobs in 2004 in the United States and approximately 5,900 jobs in Pennsylvania.
- Nearly 63 percent were employed with manufacturing establishments. About 1 in 4 worked for service-providing firms, such as engineering consulting and research and development companies.

Job Outlook

- Employment of industrial engineers in Pennsylvania is expected to grow from approximately 5,900 in 2004 to approximately 6,530 in 2014. Industrial engineers can expect about 63 openings due to growth and about 143 replacement openings for approximately 206 total annual openings.
- Because the main goal of an industrial engineer is to make a higher quality product as efficiently as possible, their services should be in demand as many firms seek to reduce costs and increase productivity.

Earnings

Average annual earnings of industrial engineers in Pennsylvania were \$68,920 in 2005. The entry-level wage in 2005 was \$45,770 while an experienced industrial engineer made \$80,490.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level industrial engineer jobs, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring the work experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities and computers can also be beneficial.

Continuing education is essential for all industrial engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of industrial engineers include engineering, natural science & computer managers; engineering & science technicians; physical & life scientists; mathematicians; computer systems analysts; computer engineers; computer scientists; and architects.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Institute of Industrial Engineers, 3577 Parkway Lane, Suite 200, Norcross, GA 30092. Internet: <http://www.iienet.org>
- The National Society of Professional Engineers, 1420 King St., Alexandria, VA 22314-2794. Internet: <http://www.nspe.org>
- American Society of Safety Engineers, 1800 E Oakton St., Des Plaines, IL 60018. Internet: <http://www.asse.org>
- Board of Certified Safety Professionals, 208 Burwash Ave., Savoy, IL 61874. Internet: <http://www.bccsp.org>

Inspectors & Compliance Officers

SOC CODES: 13-1041, 13-2061, 17-2111, 19-2041, 29-9011, 29-9012, 45-2011 and 53-6051

Significant Points

- Because job functions are so diverse, entry-level occupational requirements vary widely.
- Most worked for government agencies.

Nature of the Work

- Inspectors and compliance officers are responsible for keeping work environments safe, food healthy, and the environment clean. The duties performed will vary with area of responsibility and level of experience.
 - Aviation safety inspectors* work for the Federal Aviation Administration (FAA) and oversee the avionics, maintenance, and operations of air carrier establishments.
 - Bank examiners* investigate financial institutions and their compliance with Federal or State regulations that govern the institution's operation and solvency.
 - Consumer safety officers* inspect food, feeds, pesticides, biological products, cosmetics, drugs, medical equipment, and radiation emitting products.
 - Environmental health inspectors* analyze substances in order to determine contamination or the presence of disease. They ensure that the quality of food, water, and air meets government standards.
 - Equal opportunity specialists* enforce laws and regulations that prohibit discrimination in employment and the provision of services on the basis of race, color, national origin, religion, sex, disability, and age.
 - Food Inspectors* ensure that food products are fit for human consumption and in compliance with Federal laws. Processing food inspectors specialize in processed ingredients that are contained in the final product.
 - Mine safety and health inspectors* conduct on-site inspections of mines, mills, and quarries in search of conditions that are potentially hazardous to the safety and health of workers.
 - Occupational Safety and Health Administration (OSHA) inspectors* serve as expert consultants on the application of safety principles, practices, and techniques in the workplace.
 - Park rangers* enforce laws and regulations in State and national parks.
 - Securities compliance examiners* implement regulations concerning securities and real estate transactions.
- Other inspectors and compliance officers include attendance officers, logging operations inspectors, coroners, travel accommodations raters, code inspectors, mortician investigators, and dealer-compliance representatives.

Working Conditions

- Many inspectors and compliance officers work long, irregular hours. Considerable fieldwork and frequent travel may be required. Workers are usually reimbursed for their travel expenses.
- Working environments may be unpleasant, stressful or dangerous. For example, food inspectors may work near machinery or in confined areas with livestock. Park rangers often work outdoors in rugged terrain and extreme temperature differences.
- Inspectors may find themselves in an adversarial role when the organization or individual being inspected objects to the process or its consequences.

Employment

- Inspectors and compliance officers held about 391,500 jobs in 2004 in the United States and approximately 14,080 jobs in Pennsylvania.
- About 44 percent were employed with Federal, state and local government agencies. Another 27 percent worked for service-providing companies.
- The following table includes the industry groups that employed the most inspectors and compliance officers in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Government	6,150	43.7%
Services	3,830	27.2%
Finance & Insurance	1,640	11.6%
Manufacturing	1,160	8.2%

Job Outlook

- Employment of inspectors and compliance officers in Pennsylvania is expected to grow from approximately 14,080 in 2004 to approximately 15,010 in 2014. Inspectors and compliance officers can expect about 93 openings due to growth and about 323 replacement openings for approximately 416 total annual openings.
- Employment growth will be relatively steady as the public demand for a safe environment and quality products offsets the desire to limit government regulations.
- General economic fluctuations seldom affect employment growth. Government agencies, which employ the most inspectors and compliance officers, provide considerable job security.

Earnings

- In Pennsylvania, inspectors and compliance officers averaged \$43,000 to \$70,000 annually in 2005. Entry-level workers earned between \$19,000 and \$47,000, while experienced inspectors and compliance officers were paid anywhere from \$48,000 to \$84,000.
- Financial examiners earned the highest average annual and experienced level wages, while entry-level wages were greatest for health and safety engineers. Occupational health and safety technicians had the lowest average annual and entry-level wages.
- The following table includes the average annual, entry level, and experienced level wages in 2005 for inspectors and compliance officers in Pennsylvania.

Occupational Title	Average Annual Wage	Entry Level Wage	Experienced Level Wage
Compliance Officers	\$50,080	\$31,320	\$59,450
Financial Examiners	\$69,050	\$39,940	\$83,610
Health & Safety Engineers	\$64,880	\$46,250	\$74,190
Environmental Scientists & Specialists	\$59,330	\$33,540	\$72,220
Occupational Health & Safety Specialists	\$53,930	\$32,640	\$64,570
Occupational Health & Safety Technicians	\$43,310	\$19,640	\$55,140
Agricultural Inspectors	\$44,100	\$34,330	\$48,990
Transportation Inspectors	\$52,030	\$22,330	\$66,880

Training, Other Qualifications and Advancement

Because job functions are so diverse, the occupational requirements for inspector and compliance officer positions vary widely. However, some combination of education, experience, and passing examination scores is usually required. Many employers prefer a college degree and previous experience in the area being investigated.

Position-specific laws and procedures are usually taught through on-the-job training and classroom instruction. In addition, certain positions require special licenses and certifications. For example, aviation safety inspectors must possess a valid pilot's license.

Aspiring inspectors and compliance officers should be responsible people who like detailed work. Strong communication skills are very important. For certain positions, applicants may have to meet strict medical requirements and be able to perform arduous duties efficiently.

Inspectors and compliance officers with satisfactory job performance often advance through a career ladder to a specified full-performance level. For positions above this level, advancement becomes competitive. Appointments are made based on agency needs and the individual's merit.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of inspectors and compliance officers include construction inspectors, building inspectors, fish and game wardens, fire marshals, law enforcement professionals, and correctional officers.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>

Materials Engineers

SOC CODE: 17-2131

Significant Points

- A bachelor's degree is required for most entry-level positions.
- Continuing education is essential to keep informed of the latest technology.

Nature of the Work

- **Materials engineers** manipulate the atomic and molecular structure of substances to create new materials. They may also test and evaluate existing materials for new applications.
- **Metallurgical engineers** specialize in metals. They work in one of three main branches of metallurgy—extractive, physical and mechanical.

Extractive metallurgists obtain useful metals by refining and alloying metals from ore.

Physical metallurgists study the nature, structure and physical properties of metals and their alloys. They may also research methods of processing them into final products.

Mechanical metallurgists develop and improve metalworking processes.

- Individuals who specialize in ceramics are known as *ceramic engineers*. They are responsible for developing new materials and methods for making useful products out of ceramic materials.

Working Conditions

- Materials engineers usually work 40 hours per week. Pressing deadlines may result in longer work hours and considerable stress.
- Occasional travel may be required.
- Work may be performed in office buildings, laboratories or industrial plants.

Employment

- Materials engineers held about 21,400 jobs in 2004 in the United States and approximately 1,160 jobs in Pennsylvania.
- Over 64 percent worked for manufacturing companies, primarily in iron and steel mills. Others worked in research and development companies.

Job Outlook

- Employment of materials engineers in Pennsylvania is expected to grow from approximately 1,160 in 2004 to approximately 1,270 in 2014. Materials engineers can expect about 11 openings due to growth and about 31 replacement openings for approximately 42 total annual openings.
- Most of the available job openings will be found in the manufacturing industry sector, which employs the most materials engineers.

Earnings

Average annual earnings of materials engineers in Pennsylvania were \$69,150 in 2005. The entry-level wage in 2005 was \$46,660 while an experienced materials engineer made \$80,390.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level materials engineer jobs, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities and computers can also be beneficial.

Continuing education is essential for all materials engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of materials engineers include engineering, natural science & computer managers; engineering technicians; science technicians; physical scientists; life scientists; mathematicians; computer systems analysts; computer engineers; computer scientists; and architects.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- The Minerals, Metals & Materials Society, 184 Thorn Hill Rd., Warrendale, PA 15086-7514.
Internet: <http://www.tms.org>
- ASM International Foundation, 9639 Kinsman Rd., Materials Park, OH 44073-0002.
Internet: <http://www.asm-intl.org>

Mechanical Engineers

SOC CODE: 17-2141

Significant Points

- Most entry-level jobs require a bachelor's degree.
- This is the broadest engineering discipline.
- Job prospects will be best in manufacturing companies and consulting firms.

Nature of the Work

- **Mechanical engineers** research, develop, design, test and manufacture tools, engines and machinery. Specific duties will vary by industry and job function.
- This is the broadest engineering discipline, extending across many specialties. As a result, mechanical engineers may work in production operations, maintenance or technical sales.
- Computers are used to perform complex modeling and simulation.

Working Conditions

- Many mechanical engineers work a standard 40-hour week. Deadlines or design standards may result in extra pressure, longer hours and considerable stress.
- Work is usually performed in office buildings, laboratories or industrial plants.
- Travel may be required to monitor operations or solve problems.

Employment

- Mechanical engineers held about 225,900 jobs in 2004 in the United States and approximately 7,710 jobs in Pennsylvania.
- Over 56 percent were employed with manufacturing companies. Another 22 percent worked for firms that provide professional and technical services, such as engineering consulting.
- The following table includes the industries that employed the most mechanical engineers in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Manufacturing	4,320	56.1%
Professional Services	1,680	21.8%
Federal Government	660	8.6%

Job Outlook

- Employment of mechanical engineers in Pennsylvania is expected to grow from approximately 7,710 in 2004 to approximately 8,050 in 2014. Mechanical engineers can expect about 34 openings due to growth and about 211 replacement openings for approximately 245 total annual openings.
- Employment growth in the manufacturing industry will be stimulated by increased demands for improved machinery and advanced processes.
- Additional opportunities will exist for mechanical engineers in consulting firms as companies continue to contract out their engineering services needs.

Earnings

Average annual earnings of mechanical engineers in Pennsylvania were \$67,320 in 2005. The entry-level wage in 2005 was \$45,380 while an experienced mechanical engineer made \$78,290.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level mechanical engineer jobs, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience, and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities and computers can also be beneficial.

Continuing education is essential for all mechanical engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of mechanical engineers include engineering, natural science & computer managers; engineering and science technicians; physical and life scientists; mathematicians; computer systems analysts; computer engineers; computer scientists; and architects.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- The American Society of Mechanical Engineers, 3 Park Ave., New York, NY 10016-5990.
Internet: <http://www.asme.org>
- Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096-0001.
Internet: <http://www.sae.org>
- American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Cir. NE, Atlanta, GA 30329. Internet: <http://www.ashrae.org>

Nuclear Engineers

SOC CODE: 17-2161

Significant Points

- A bachelor's degree is required for most entry-level positions.
- Employment opportunities may be affected by geographic area.
- Available openings will continue to outnumber qualified applicants.

Nature of the Work

- *Nuclear engineers* research and develop the processes, instruments and systems used to derive benefits from nuclear energy and radiation.
- They design, develop, monitor and operate nuclear plants used to generate power. They may work on the nuclear fuel cycle or on the production of fusion energy.
- Some specialize in the development of nuclear power sources for spacecraft; others find industrial and medical uses for radioactive materials, such as equipment to diagnose and treat medical problems.

Working Conditions

- Many nuclear engineers work a standard 40-hour week. At times, deadlines or design standards may result in extra pressure, longer hours and considerable stress.
- Work usually occurs near nuclear power plants. However, some projects are located in research facilities.

Employment

- Nuclear engineers held about 17,400 jobs in 2004 in the United States and approximately 2,700 jobs in Pennsylvania.
- Approximately 52 percent were employed with power generation and supply companies. Another 45 percent worked for research and development firms.

Job Outlook

- Employment of nuclear engineers in Pennsylvania is expected to decrease slightly from approximately 2,700 in 2004 to approximately 2,660 in 2014. Although there are no job openings expected to result from employment growth, nuclear engineers can expect about 81 annual openings due to replacement needs.
- Good opportunities should exist for nuclear engineers because the small number of nuclear engineering graduates is likely to be in rough balance with the number of job openings.
- Nuclear engineers may be needed to research and develop future nuclear power sources. They also will be needed to work in defense-related areas, to develop nuclear medical technology, and to improve and enforce waste management and safety standards.

Earnings

Average annual earnings of nuclear engineers in Pennsylvania were \$84,450 in 2005. The entry-level wage in 2005 was \$73,610 while an experienced nuclear engineer made \$89,860.

Training, Other Qualifications and Advancement

A bachelor's degree in engineering is generally required for entry-level nuclear engineer jobs, although graduates with a degree in a physical science or mathematics may qualify. Many colleges also offer a degree in engineering technology, which provides a graduate with skills between those of a technician and an engineer.

Pennsylvania requires engineers who offer their services to the public or whose work may affect lives, health or property to obtain a Professional Engineers (PE) license. A PE license requires a degree from an accredited engineering program, four years of work experience, and successful completion of the two-stage State examination. The initial examination, taken upon graduation, provides engineers with an Engineer in Training (EIT) certification that is valid for 10 years. After acquiring enough experience, the second examination can be taken.

Aspiring engineers should be creative, analytical and detail-oriented. They should be able to work as part of a team. Strong oral and written communication skills are essential. A solid background in mathematics and sciences is important. Courses in English, social studies, humanities and computers can also be beneficial.

Continuing education is essential for all nuclear engineers to keep informed of the latest technology. As knowledge and experience are gained, more difficult projects are assigned. In fact, many engineers obtain graduate degrees in engineering or business administration. Engineers can advance in their careers to become chief engineers, technical specialists or engineering managers.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of mechanical engineers include engineering, natural science & computer managers; engineering and science technicians; physical and life scientists; mathematicians; computer systems analysts; computer engineers; computer scientists; and architects.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Nuclear Society, 555 North Kensington Ave., LaGrange Park, IL 60526.
Internet: <http://www.ans.org>

Operations Research Analysts

SOC CODE: 15-2031

Significant Points

- Dual graduate degrees in operations research and computer science are especially attractive to employers.
- Demand should remain relatively steady in the years ahead.

Nature of the Work

- *Operations research analysts* use quantitative techniques to determine the optimal means of coordinating materials, equipment and people to achieve specific goals. They come up with multiple solutions to each problem and present their findings to management.
- Specific duties will vary with the structure and management philosophy of each employer or client.
- Computer programs are used to solve the mathematical models that are constructed by the operations research analyst. Input variables can be modified to see which set produces the best solution.
- Once management has reached a decision, analysts may work with others in the organization to ensure that the plan is successfully implemented.

Working Conditions

- Operations research analysts usually work a 40-hour week. Overtime work may be required.
- Work is usually performed in an office environment.
- Because their projects are important to management, analysts are often under pressure to meet deadlines.

Employment

- Operations research analysts held about 57,500 jobs in 2004 in the United States and approximately 1,890 jobs in Pennsylvania.
- Over 31 percent worked for companies that provide professional and technical services, such as computer systems design. Another 20 percent were employed with financial and insurance companies.
- The following table includes the industry groups that employed the most operations research analysts in 2004 in Pennsylvania.

Industry Group	2004 Employment	Percent
Professional Services	590	31.4%
Finance & Insurance	380	19.9%
Transportation & Warehousing	220	11.7%
Manufacturing	180	9.3%
Information	120	6.3%

Job Outlook

- Employment of operations research analysts in Pennsylvania is expected to grow from about 1,890 jobs in 2004 to 2,030 in 2014. Operations research analysts can expect about 14 openings due to growth and about 41 replacement openings for approximately 55 total annual openings.
- Demand for workers with this knowledge should remain relatively steady in the years ahead. However, employment growth will be slow because few job openings will have the title of operations research analyst.
- Graduates with a bachelor's degree in operations research or management science should find numerous opportunities in a variety of related fields that will allow them to use their quantitative abilities.

Earnings

Average annual earnings of operations research analysts in Pennsylvania were \$63,180 in 2005. The entry-level wage in 2005 was \$41,360 while an experienced operations research analyst made \$74,100.

Training, Other Qualifications and Advancement

Employers generally prefer to hire applicants with a master's degree in operations research, engineering, business, mathematics, information systems or management science. This degree should be coupled with a bachelor's degree in computer science, economics, mathematics or statistics. Applicants with dual graduate degrees in operations research and computer science are especially attractive to employers.

Entry-level workers perform routine tasks under the supervision of an experienced analyst. After gaining some knowledge and experience, they are assigned to more complex tasks and given greater autonomy. In addition, many employers provide continuing education courses for their experienced analysts. This allows workers to keep abreast of new developments and techniques in operations research or computer science. In some cases, companies will pay for their employees to attend advanced classes at colleges and universities.

Operations research analysts must be able to think logically and work well with other people. Strong communication skills are essential. Because computers are important for qualitative analysis, aspiring analysts need to be proficient in database management, computer programming and software development.

Experienced operations research analysts may advance to technical specialist or supervisory positions. Some leave the field to assume managerial or administrative positions in non-technical areas.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of operations research analysts include computer scientists, systems analysts, management analysts, modeling specialists, logistics consultants, engineers, mathematicians, statisticians, and economists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- Institute for Operations Research and the Management Sciences (INFORMS), 901 Elkridge Landing Rd., Suite 400, Linthicum, MD 21090-2909. Internet: <http://www.informs.org>
- Military Operations Research Society, 1703 N. Beauregard St., Suite 450, Alexandria, VA 22311. Internet: <http://www.mors.org>

Science Technicians

SOC CODES: 19-4011, 19-4021, 19-4031, 19-4041, 19-4051, 19-4091, 19-4092, 19-4093 and 19-4099

Significant Points

- Employers prefer to hire applicants with some specialized training or an associate's degree.
- Opportunities will be best for qualified graduates who are well trained on key equipment.
- Over 37 percent were employed with professional and technical consulting firms.

Nature of the Work

- Science technicians set up, operate and maintain laboratory instruments. They also monitor experiments, make observations, record results and develop conclusions. Most specialize in the same disciplines as scientists.

Agricultural technicians conduct experiments, breed animals and perform nutrition work.

Biological technicians study living organisms.

Chemical technicians develop and use chemical products and equipment.

Environmental technicians perform laboratory and field tests to monitor environmental resources and determine the sources of pollution.

Forensic technicians investigate crimes by collecting and analyzing physical evidence.

Forest and conservations technicians gather and utilize data on the condition of forests.

Nuclear technicians operate equipment, monitor radiation, and assist with research.

Petroleum technicians record physical and geologic conditions in oil or gas wells.

- Technological advancements have expanded the role of science technicians. Beyond their routine tasks, many technicians assist scientists with developing procedures, interpreting data and devising solutions.
- Most science technicians make extensive use of computers, computer-interfaced equipment, high-technology industrial applications and robotics.

Working Conditions

- Most science technicians work regular hours. Because manufacturing plants operate 24-hours a day, production technicians may work any of three eight-hour shifts. Overtime is occasionally required to monitor experiments.
- Work is usually performed in laboratories although some work occurs in remote, outdoor locations.
- Proper safety procedures must be followed to minimize the risks associated with handling equipment, chemicals, and toxic materials.

Employment

- Science technicians held about 324,000 jobs in 2004 in the United States and approximately 15,670 jobs in Pennsylvania.
- About 25 percent were employed with college and universities. Another 14 percent worked for research and development firms. Pharmaceutical manufacturing employed about 1 in 10.
- The following table includes the industries that employed the most science technicians in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Colleges & Universities	3,910	24.9%
Scientific Research & Development Services	2,130	13.6%
Pharmaceutical & Medicine Manufacturing	1,580	10.1%
Architectural & Engineering Services	1,110	7.1%
Employment Services	840	5.3%

Job Outlook

- Employment of science technicians in Pennsylvania is expected to grow from approximately 15,670 in 2004 to approximately 17,130 in 2014. Science technicians can expect about 146 openings due to growth and about 355 replacement openings for approximately 501 total annual openings.

- Employment growth will be stimulated by increases in scientific and medical research as well as the development and production of technical products. However, this growth may be offset by the expected slowdown in the chemical industry.
- Job opportunities will be best for qualified graduates who are well trained on equipment that is used in industrial and government laboratories.

Earnings

- In Pennsylvania, science technicians averaged \$32,100 to \$45,900 annually in 2005. The entry-level earnings were between \$22,400 and \$28,500, while experienced science technicians were paid anywhere from \$37,000 to \$54,600.
- The following table includes the average hourly, entry level, and experienced level wages in 2005 for science technicians in Pennsylvania.

Occupational Title	Average Hourly Wage	Entry Level Wage	Experienced Level Wage
Agricultural & Food Science Technicians	\$42,120	\$27,820	\$49,270
Biological Technicians	\$34,040	\$22,460	\$39,840
Chemical Technicians	\$38,070	\$26,060	\$44,070
Geological & Petroleum Technicians	\$43,150	\$27,750	\$50,840
Nuclear Technicians	N/A	N/A	N/A
Environmental Science & Protection Technicians	\$32,190	\$22,480	\$37,040
Forensic Science Technicians	\$43,940	\$28,430	\$51,690
Forest & Conservation Technicians	N/A	N/A	N/A
Life, Physical & Social Science Technicians, Other	\$45,820	\$28,320	\$54,570

- No Pennsylvania-specific information was available for nuclear technicians. However, the average salary nationwide for nuclear technicians in 2005 was \$59,840.
- No Pennsylvania-specific information was available for forest & conservation technicians. However, the average salary nationwide for forest and conservation technicians in 2005 was \$31,480.

Training, Other Qualifications and Advancement

Employers generally prefer to hire science technicians that have two years of specialized training or an associate degree in applied science or science-related technology. However, some technicians obtain a bachelor's degree in chemistry or biology.

Many technical and community colleges offer associate's degree programs. Technical institutes also offer training but provide less theory and general education than technical or community colleges. Training can vary in length, although one-year certificate and two-year associate degree programs are most common. Some schools also offer cooperative-education programs or internships. Participation in these programs can significantly enhance a student's employment prospects.

Aspiring science technicians should be able to work well with others. Strong oral and written communication skills are essential. Background knowledge in science, math and computers is beneficial.

Most science technicians are hired as trainees. Under the guidance of a scientist or experienced technician, these entry-level workers learn how to perform routine tasks. After gaining experience, technicians are given more responsibilities. Some even advance to supervisory positions. Technicians employed with universities often have their fortunes tied to a particular professor. When that professor leaves or retires, the technician may face uncertain employment prospects.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of science technicians include engineering technicians, broadcast technicians, drafters, and health technologists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Chemical Society, 1155 16th St. NW, Washington, DC 20036. Internet: <http://www.acs.org>
- American Academy of Forensic Sciences, P.O. Box 669, Colorado Springs, CO, 80901.
Internet: <http://www.aafs.org>
- Society of American Foresters, 5400 Grosvenor Ln., Bethesda, MD 20814-2198.
Internet: <http://www.safnet.org>

Statisticians

SOC CODE: 15-2041

Significant Points

- Most jobs require a master's degree in statistics or mathematics.
- Job opportunities should remain favorable for individuals with degrees in statistics.
- Many individuals with degrees in statistics enter jobs that do not have the title statistician.

Nature of the Work

- *Statisticians* apply their mathematical and statistical knowledge to the design of surveys and experiments; collection, processing, and analysis of data; and interpretation of the results.
- They may apply their knowledge of statistical methods to a variety of subject areas, such as biology, economics, engineering, medicine, public health, psychology, marketing, education and sports.

Working Conditions

- Statisticians usually work regular hours in comfortable offices.
- Some statisticians travel to provide advice on research projects, supervise and set up surveys or gather statistical data.
- Statisticians who work in academia generally have a mix of teaching and research responsibilities.

Employment

- Statisticians held about 18,900 jobs in 2004 in the United States and around 580 jobs in Pennsylvania.
- About 22 percent worked for pharmaceutical manufacturing companies. Others were employed with consulting firms and educational institutions.
- The following table includes the industries that employed the most statisticians in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Pharmaceutical & Medicine Manufacturing	130	22.2%
Management & Technical Consulting Services	70	12.1%
Colleges & Universities	70	12.1%
Other Professional & Technical Services	70	12.1%

Job Outlook

- Employment of statisticians in Pennsylvania is expected to grow from approximately 580 in 2004 to approximately 640 in 2014. These workers can expect about 6 openings due to growth and about 15 replacement openings for approximately 21 total annual openings.
- Despite the limited number of jobs resulting from growth, a number of openings will become available as statisticians transfer to other occupations or retire or leave the work force for other reasons.
- Among graduates with a master's degree in statistics, those with a strong background in an allied field, such as finance, biology, engineering or computer science, should have the best prospects of finding jobs related to their field of study.

Earnings

Average annual earnings of statisticians were \$60,690 in 2005. The entry-level wage in 2005 was \$34,800, while an experienced statistician made \$73,640.

Training, Other Qualifications and Advancement

Although more employment opportunities are becoming available to individuals with a bachelor's degree in statistics, a master's degree in statistics or mathematics is usually the minimum educational requirement for most statistician jobs. For example, research and academic positions in institutions of higher education require at least a master's degree, and usually a Ph.D., in statistics. Beginning positions in industrial research often require a master's degree combined with several years of experience. However, the training

required for employment as an entry-level statistician in the Federal Government is a bachelor's degree, including at least 15 semester hours of statistics or a combination of 15 hours of mathematics and statistics.

In 2004, approximately 140 universities offered a master's degree program in statistics or biostatistics, and about 90 offered a doctoral degree program. Many other schools also offered graduate-level courses in applied statistics for students majoring in biology, business, economics, education, engineering, psychology and other fields. Acceptance into graduate statistics programs does not require an undergraduate degree in statistics, although good training in mathematics is essential.

Because computers are used extensively for statistical applications, a strong background in computer science is highly recommended. For positions involving quality and productivity improvement, training in engineering or physical science is useful. A background in biological, chemical or health science is important for positions involving the preparation and testing of pharmaceutical or agricultural products. Courses in economics and business administration are helpful for many jobs in market research, business analysis and economic forecasting.

Good communications skills are important for prospective statisticians in industry, who often need to explain technical matters to persons without statistical expertise. An understanding of business and the economy also is valuable for those who plan to work in private industry.

In general, entry-level statisticians are supervised by experienced statisticians. With experience, they may advance to positions with more technical responsibility and, in some cases, supervisory duties. However, opportunities for promotion are greater for persons with advanced degrees. Master's and Ph.D. degree holders usually enjoy independence in their work and become qualified to engage in research, develop statistical methods, or, after a number of years of experience in a particular area, become statistical consultants.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of statisticians include actuaries; mathematicians; operations research analysts; computer systems analysts; database administrators; computer scientists; computer programmers; computer software engineers; engineers; economists & market research analysts; financial analysts & personal financial advisors; and life, physical & social scientists.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Statistical Association, 1429 Duke St., Alexandria, VA 22314. Internet: <http://www.amstat.org>
- American Mathematical Society, 201 Charles St., Providence, RI 02940. Internet: <http://www.ams.org>

Surveying & Mapping Specialists

SOC CODES: 17-1021, 17-1022 and 17-3031

Significant Points

- Surveyors must be licensed to work in Pennsylvania.
- Opportunities should be best for individuals with a bachelor's degree and strong technical skills.
- Voluntary certification is available for surveying technicians and photogrammetrists.

Nature of the Work

- Surveying specialists provide data relevant to the shape, contour, location or elevation of the land. Work is often performed by a group of individuals, commonly referred to as a survey party.
 - Land surveyors* lead the survey party. They establish official land, air and water boundaries.
 - Surveying technicians* operate survey instruments, collect information, compile notes and enter data.
 - Helpers* perform less skilled duties, such as clearing brush or carrying equipment.
- Mapping scientists perform geographical research, compile the information and complete actual map production. They collect, analyze and interpret spatial and non-spatial data.
 - Cartographers* measure and chart the earth's surface. This information is used to produce maps in digital or graphic forms.
 - Photogrammetrists* use aerial photographs to prepare drawings of areas that are inaccessible or difficult to survey by other methods.
 - Map editors* develop and verify map contents from aerial photographs and other reference sources.
 - Geographic information specialists* use computerized equipment to collect and analyze geographic data.
- Some surveyors perform specialized functions that are closer to those of a cartographer.
 - Geodetic surveyors* measure large areas of the earth's surface.
 - Geophysical prospecting surveyors* mark sites for subsurface exploration.
 - Marine surveyors* monitor harbors, rivers and other bodies of water.
- Technological advancements have greatly changed the surveying and cartography industries. For example, the Global Positioning Systems (GPS) uses radio signals and satellites to precisely locate points on the earth.

Working Conditions

- Most surveying & mapping specialists work a traditional 40-hour week. Longer hours may be required during the summer months.
- Surveyors and technicians spend most of their time outdoors at the survey site. Cartographers, on the other hand, usually work in offices and rarely visit the sites they are mapping.
- Land surveyors perform strenuous work. They often stand for long periods, walk considerable distances and climb hills with heavy packs.
- Travel to the survey site is often required. Workers may commute, stay overnight or temporarily relocate.

Employment

- Surveying & mapping specialists held about 131,500 jobs in 2004 in the United States and approximately 3,870 jobs in Pennsylvania.
- About 65 percent were employed with consulting firms that provide engineering and architectural services. Others were employed with government agencies.
- The following table includes the industries that employed the most surveying & mapping specialists in 2004 in Pennsylvania.

Industry	2004 Employment	Percent
Architectural & Engineering Services	2,510	65.0%
Government	420	10.8%
Semiconductor & Electronic Components	260	6.8%

Job Outlook

- Employment of surveying & mapping specialists in Pennsylvania is expected to decrease from approximately 3,870 in 2004 to approximately 3,760 in 2014. About 137 annual openings will result from replacement needs. Although no net employment growth is expected statewide, growth openings may occur in some areas.
- Job opportunities should be best for applicants who have a bachelor's degree and strong technical skills.
- Increasing demand for geographic data will mean better opportunities for cartographers and photogrammetrists involved in the development and use of geographic and land information systems.

Earnings

- In Pennsylvania, surveying & mapping specialists averaged \$31,300 to \$45,700 annually in 2005. The entry-level earnings were between \$20,300 and \$32,700, while experienced surveying & mapping specialists were paid anywhere from \$36,800 to \$52,200.
- The following table includes the average hourly, entry level, and experienced level wages in 2005 for surveying & mapping specialists in Pennsylvania.

Occupational Title	Average Hourly Wage	Entry Level Wage	Experienced Level Wage
Cartographers & Photogrammetrists	\$37,190	\$25,690	\$42,950
Surveyors	\$45,660	\$32,660	\$52,160
Surveying & Mapping Technicians	\$31,320	\$20,330	\$36,810

Training, Other Qualifications and Advancement

Employers generally prefer to fill open positions with applicants who have completed a formal training program, although high school graduates with no additional training may be hired as apprentices. Programs in surveying and surveying technology are offered at various universities, junior colleges, community colleges and vocational-technical institutes. Graduates enter the surveying industry as technicians or assistants. With experience and formal training, they may advance to senior survey technician, party chief or surveyor positions.

Surveyors must be licensed to work in Pennsylvania. Licensure requirements include postsecondary education, significant work experience, and a passing score on both required examinations. The quickest route to licensure is a combination of a four-year degree, two to four years of work experience, and a passing examination score. Although certification for technicians is voluntary, it may increase one's promotional opportunities. The American Congress on Surveying and Mapping offers certification at four levels, each requiring progressive amounts of experience. Qualified applicants must pass a written examination before they become certified.

Most cartographers and photogrammetrists graduate with a bachelor's degree in engineering, forestry, geography or another physical science. However, individuals with limited postsecondary education may enter these positions as technicians. With advances in technology, these workers need stronger technical skills and more experience with computers. Voluntary certification is available for experienced photogrammetrists. To become certified, applicants must obtain a passing score on both the oral and written examinations.

Individuals interested in a career as a surveying or mapping specialist must have the ability to precisely and accurately visualize objects, distances, sizes and abstract forms. Strong interpersonal skills are needed to work efficiently as part of a team. Because they perform such strenuous work, members of a survey party must be in good physical condition. In addition, these workers need good eyesight, coordination, and communication skills.

Related Occupations

Workers in other occupations with responsibilities and duties related to those of surveying & mapping specialists include architects, geologists, geophysicists, geographers, environmental scientists, urban planners, civil engineers and civil engineering technicians.

Sources of Additional Information

- Pennsylvania CareerLink. Internet: <http://www.pacareerlink.state.pa.us>
- American Congress on Surveying and Mapping, 6 Montgomery Village Ave., Suite 403, Gaithersburg, MD, 20879. Internet: <http://www.acsm.net>
- The American Society for Photogrammetry and Remote Sensing, 5410 Grosvenor Lane, Suite 210, Bethesda, MD 20814-2160. Internet: <http://www.asprs.org>